An Index *to the* Chemical Action *of* Microorganisms *on the* Non-Nitrogenous Organic Compounds

AN INDEX TO THE CHEMICAL ACTION OF MICROORGANISMS ON THE NON-NITROGENOUS ORGANIC COMPOUNDS

by

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PREFACE

The material presented in this volume is a summary of information in the process of organization for several years, being maintained both in card index and tabular form. These data have been consulted on numerous occasions by various workers in the field of zymology. At the urgent request of these workers, who have found our files and tables useful, we are making this information more generally available in the present form. It is our hope that this index will be of definite value in the rapidly developing field of zymology.

Ellis I. Fulmer
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Iowa State College
January 24, 1930

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INTRODUCTION

In the course of studies on the production of chemicals from agricultural wastes by the action of microorganisms it seemed advisable to obtain a comprehensive view of the chemicals which have been reported as produced by the action of bacteria, yeasts, and molds on various substrates. A survey was made with reference to non-nitrogenous compounds since such compounds furnish the important sources of energy for the organisms and for the zymotechnical production of chemicals on a large scale. This study was further limited to those instances in which a named organism acted on a named substrate to produce a named compound.

To cover the literature completely even with the above limitations would involve so much material as to become unwieldy. *The purpose of this survey* is to cite references involving a variety of organisms, substrates, products, and authorities; that is, to give a cross section of the field complete enough to introduce the reader to the subject. Hence the authors have purposely omitted much material on the more common types of fermentation with only typical references, while for more uncommon types the treatment has been practically complete. Since the purpose is not primarily historical many of the older references have been omitted and later work cited.

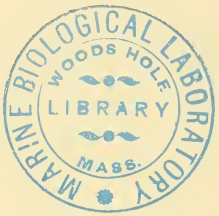
A survey was likewise made of the media and analytical methods for each reference listed. This information will be reserved for a further communication. However, a few general remarks may be pertinent. For example, it is an open question whether in some instances succinic acid is produced from the non-nitrogenous substrate or is a secondary product resulting from the breakdown of the cell or is due to the action upon glutaminic acid. Oxidation and reduction (dehydrogenation and hydrogenation) may in some instances be due to conditions in the medium rather than to direct action of the living organisms. The recent work of Conant and Aston (1928), for example, has shown the production of acetone, carbon dioxide,

complex crystalline bodies, and gummy substances, by the oxidation of isobutyraldehyde by potassium permanganate or potassium dichromate under the given conditions of temperature and relative concentrations of the reagents. The material at hand likewise shows that one of the immediate needs in the field of zymology is the development and consistent use of adequate analytical methods for the fermentation products.

The names ascribed to the microorganisms by the various investigators have been listed as they are given in the original communication. In case the generic or specific designation has been changed since that time the later name has been cross-indexed. The use of an author's name for an organism has been given to identify it. When the statement is made that a certain organism was used to produce definite products, no attempt was made by the authors of this index to judge the purity of the culture. The technique in many instances has not been such as to warrant the conclusions which have been drawn with regard to the ability of the organism to bring about the action reported. It is unfortunate that occasionally investigators will execute a very careful piece of research from a chemical point of view and fail to describe the organism with which the work was done, merely referring to it as a "bacillus." Reference to a number of publications has been omitted for this reason. Frequently a description of an organism has been given which may be adequate for purposes of classification but no name has been attached. The authors wish to emphasize the importance of a proper use of bacterial taxonomy in chemical studies of fermentation.

The results of the literature survey made with the limitations above outlined are presented in three Tables involving the four items: *organism*, *substrate*, *product* and *authority*. *In Table 1* they are shown in the order named above. This compilation enables the reader to gain an idea of the general chemical actions of a given organism and to compare them with others. *In Table 2* the order is *substrate*, *product*, *organism*, *authority*, enabling the reader at a glance to gain an idea of the various products elaborated from a given substrate by the organism involved. It is of interest to note that the products

from the pentoses are of the same types as those produced from the hexoses. The order *in Table 3* is *product*, *substrate*, *organism*, *authority*, enabling the reader to find the types of substrate from which a given chemical has been reported as produced by the named organisms. At the end of the paper is given the list of references cited. It is the hope of the authors that this treatment, limited as it is, may be of value ingiving an adequate key to the literature on the chemical changes produced by microorganisms acting on non-nitrogenous organic compounds.



CHAPTER I

INDEX TO MICROORGANISMS

CHAPTER I

TABLE ONE

INDEX TO MICROORGANISMS

Microorganisms Substrates	Products Authors
Acetobacter acetum	
(See *Mycoderma aceti*)	
(See *Bact. aceti*)	
Acetobacter ascendens	
(See *Bact. ascendens*)	
Acetobacter melanogenum	
butyl alc.	butyric ac. Visser't Hooft, 1925
isobutyl alc.	isobutyric ac. Visser't Hooft, 1925
isopropyl alc.	acetone Visser't Hooft, 1925
lactic ac.	acetic ac. Visser't Hooft, 1925
propyl alc.	propionic ac. Visser't Hooft, 1925
Acetobacter sorbose	
(See also sorbose bacterium)	
xylose	CO_2 Fred, Peterson and Anderson 1923
Acetobacter suboxydans	
adonitol	d-adoninulose Visser't Hooft, 1925
2, 3-butylene glycol	acetone Visser't Hooft, 1925
ethyl alc., lactic ac.	acetic ac. Visser't Hooft, 1925
erythritol	erythrose Kluyver and deLeeuw, 1924

Microorganisms Substrates	Products Authors
Acetobacter suboxydans (cont.)	
gluconic ac.	hydroxygluconic ac. Kluyver and deLeeuw, 1924
glycerol	dihydroxy-acetone Kluyver and deLeeuw, 1924
glycerol	dihydroxy-acetone Brit. patent, 269,950
isopropyl alc.	acetone Visser't Hooft, 1925
mannitol	levulose Kluyver and deLeeuw, 1924
sorbitol	sorbose Kluyver and deLeeuw, 1924
Acetobacter sp.?	
ethyl alc.	acetic ac. Knieriem and Mayer, 1872
ethyl alc.	acetic ac. Buchner and Gaunt, 1906
ethyl alc.	acetic ac. Day and Baker, 1913
ethyl alc.	acetic ac. Söhngen, 1913
gluconic ac.	dihydroxyacetone, ethyl alc. Söhngen, 1914, 1915
glucose	acetic ac., CO_2, ethyl alc., gluconic ac. Söhngen, 1914, 1915
propyl alc.	propionic ac. Buchner and Gaunt, 1906
Acetobacter xylinum (See also *Bact. xylinum*) (See also *B. xylinum*) (See also sorbose bacterium)	
2, 3-butylene glycol	acetone Visser't Hooft, 1925

Microorganisms Substrates	Products Authors
Acetobacter xylinum (cont.)	
isopropyl alc.	acetone Visser't Hooft, 1925
lactic ac.	acetic ac. Visser't Hooft, 1925
d-propylene glycol	acetol Visser't Hooft, 1925
xylose	acetone, CO_2, ethyl alc. Fred, Peterson and Anderson, 1923
Actinomyces sp.?	
xylan	pentose (xylose?) Patrick, Werkman and Hixon, 1930
Aerobacillus acetoethylicus (See *B. acetoethylicus*)	
Aerobacillus asterosporus (See *B. polymyxa*)	
Aerobacillus macerans (See *B. macerans*)	
Aerobacillus polymyxa (See *B. polymyxa*)	
Aerobacter aerogenes (See *B. lactis aerogenes*) (See *Bact. lactis aerogenes*)	
Aerobacter cloacae (See *B. cloacae*)	
Aerobacter faeni	
sucrose, xylose	acetic ac., acetylmethyl carbinol, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Breden, Fulmer, Werkman and Hixon, 1930

Microorganisms Substrates	Products Authors
Amylobacter butylicus (See also *B. amylobacter*)	
glycerol, lactic ac.	acetic ac., butyl alc., butyric ac. Duclaux, 1895
lactose, maltose, mannitol, starch, sucrose	acetic ac., butyl alc., butyric ac., CO_2, ethyl alc., H_2, lactic ac. Duclaux, 1895
Amylobacter ethylicus	
sucrose	acetic ac., acetaldehyde, ethyl alc., lactic ac. Duclaux, 1895
Amylomyces Rouxii	
lactic ac.	pyruvic ac. Mazé, 1916
Aspergillus cellulosae	
dextrose	acetaldehyde Cohen, 1920
Asp. cinnamoneus	
dextrose	citric ac., gluconic ac. Falck and Kapur, 1924
Asp. fumaricus	
arabinose	fumaric ac., citric ac. Schreyer, 1928
dextrose, gluconic ac., glyceric ac., glycerol, lactic ac., mannitol	citric ac. Schreyer, 1928
galactose	fumaric ac., citric ac. Schreyer, 1928
gluconic ac.	citric ac. Schreyer, 1925, 1928
glyceric ac.	citric ac. Schreyer, 1928
sucrose	fumaric ac. Wehmer, 1918
sucrose	citric ac., fumaric ac., gluconic ac., malic ac. Wehmer, 1928

Microorganisms Substrates	Products Authors
Asp. fuscus	
dextrose	citric ac., gluconic ac. Falck and Kapur, 1924
Asp. glaucus	
glycerol	hydro-oxymaltol Traetta-Mosca and Preti, 1921
Asp. niger	
acetic ac.	glycollic ac., glyoxylic ac., oxalic ac. Challenger, Subramaniam and Walker, 1927
acetic ac., dextrose, starch, tartaric ac.	oxalic ac. Wehmer, 1891
acetonedicarboxylic ac.	oxalic ac. Walker, Subramaniam and Challenger, 1927
arabinose, dextrose, galactose, glycerose, levulose, maltose, mannose, sucrose, xylose	citric ac. Amelung, 1927
arabinose, gluconic ac., glycerol, mannitol, quinic ac., saccharic ac. sucrose	citric ac., oxalic ac. Butkewitsch, 1923
arabinose, dextrose, glycerol, levulose, mannitol, sucrose	gluconic ac. Bernhauer, 1928
butyric ac.	β-hydroxybutyric ac., acetoacetic ac., acetone Koppock, Subramaniam and Walker, 1928
cinnamic ac.	styrol Herzog and Ripke, 1908
citric ac.	acetone, glyoxylic ac., malonic ac., oxalic ac. Challenger, Subramaniam and Walker, 1927
citric ac.	acetonedicarboxylic ac. Walker, Subramaniam and Challenger, 1927

Microorganisms Substrates	Products Authors
Asp. niger (cont.)	
citric ac.	glycollic ac. Challenger, Subramaniam and Walker, 1927
citric ac.	oxalic ac. Challenger, Subramaniam and Walker, 1927
dextrin, dextrose, glycerol, inulin, lactose, mannitol, sucrose	citric ac., oxalic ac. Elfving, 1919
dextrose	acetic ac., oxalic ac. Heinze, 1903
dextrose, sucrose	citric ac. Bernhauer, 1928
dextrose	citric ac., gluconic ac. Falck and Kapur, 1924
dextrose	citric ac., oxalic ac. Wehmer, 1924
dextrose	ethyl alc., CO_2 Kostytschew, 1907
dextrose	gluconic ac. Müller, 1925
dextrose	oxalic ac. Wehmer, 1897
fumaric ac.	l-malic ac. Challenger and Klein, 1929
gluconic ac.	citric ac., saccharic ac. Walker, Subramaniam and Challenger, 1927
gluconic ac.	citric ac., oxalic ac. Wehmer, 1925
oxalic ac.	glycollic ac. Challenger, Subramaniam and Walker, 1927
phloridzin	phloroglucinol, dextrose Boas, 1916

Microorganisms Substrates	Products Authors
Asp. niger (cont.)	
raffinose	oxalic ac. Gillot, 1899
saccharic ac.	citric ac. Walker, Challenger and Subramaniam, 1927
succinic ac., fumaric ac., malic ac., tartaric ac., acetic ac.	oxalic ac. Raistrick and Clark, 1919
sucrose	citric ac. Currie, 1917
sucrose	citric ac., gluconic ac., oxalic ac. Bernhauer, 1924
sucrose	citric ac., gluconic ac., oxalic ac. Butkewitsch, 1924
sucrose	citric ac., gluconic ac., oxalic ac. Bernhauer, 1926
sucrose	kojic ac. Kinoshita, 1927
sucrose	oxalic ac. Currie, 1919
tartaric ac., lactic ac., quinic ac., glycerol, mannitol, sucrose	ethyl alc. Kostytschew and Afanassjewa, 1922
Asp. niger-mutante	
pyruvic ac.	acetaldehyde Nagayama, 1921
Asp. oryzae	
quinic ac.	protocatechuic ac., pyrocatechol Butkewitsch, 1924
sucrose	kojic ac. Kinoshita, 1927
Bacillus acetobutylicus (See *Cl. acetobutylicum*)	

Microorganisms Substrates	Products Authors
B. aceti*	
arabinose, dextrose, erythritol ethyleneglycol, glycerol, glycollic ac., isobutyric ac., isolichenin, levulose, malonic ac., rhamnose, sucrose	oxalic ac. Banning, 1902
B. aceti (Hansen)	
ethyl alc.	acetic ac. Buchner and Gaunt, 1906
propyl alc.	propionic ac. Buchner and Gaunt, 1906
B. aceti viscosum	
dextrose	gluconic ac. Day and Baker, 1913
ethyl alc.	acetic ac. Day and Baker, 1913
B. acetigenum	
arabinose, dextrose, glycollic ac.	oxalic ac. Banning, 1902
dextrose	gluconic ac. Henneberg, 1898
B. acetoethylicum	
arabinose, dextrose, galactose, glycerol, lactic ac., levulose, maltose, mannose, raffinose, starch, sucrose, xylose	acetone, ethyl alc., formic ac. Northrop, Ashe and Morgan, 1919
dextrose, maltose	acetone, ethyl alc., pyruvic ac. Speakman, 1925

* While *B.* usually designates *Bacillus*, this symbol is used occasionally for *Bacterium*, and leads to confusion. The authors have used the designation of the authorities cited.

Microorganisms Substrates	Products Authors
B. acetoethylicum (cont.)	
dextrose, starch, sucrose, xylose	acetic ac., acetone, ethyl alc., formic ac., lactic ac. Arzberger, Peterson and Fred, 1920
starch	acetaldehyde Peterson and Fred, 1920
B. acetoethylicus	
dextrose	acetic ac., acetylmethyl carbinol, acetone, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac. Donker, 1926
starch, sucrose	acetone, ethyl alc. Bakonyi, 1926
B. acetosum	
arabinose, dextrin, dextrose, erythritol, ethyleneglycol, glycollic ac., malonic ac.	oxalic ac. Banning, 1902
dextrose	gluconic ac. Henneberg, 1898
B. acidi-laevolactici	
sucrose	l-lactic ac. Schardinger, 1890
B. acidi propionici (See *Propionibacterium pentosaceum*)	
B. acidi propionici	
lactic ac.	acetic ac., CO_2, propionic ac. von Fruedenreich and Jensen, 1906
Bacillus aerogenes (See *B. lactis aerogenes*)	

Microorganisms Substrates	Products Authors
B. aerogenes	
dextrose	acetic ac., acetylmethyl carbinol, 2, 3-butyleneglycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Scheffer, 1928
B. amaracrylus	
glycerol	acrylaldehyde Voisenet, 1918
B. amarificans	
(See *B. lactis*)	
B. amylobacter	
(See *Clostridium butyricum*)	
(See *Granulobacter butylicum*)	
B. anthracis	
maltose, sucrose	acetylmethyl carbinol Lemoigne, 1919
starch	dextrose Maumus, 1893
B. ascendens	
(See also *Acetobacter ascendens*)	
(See also *Bact. ascendens*)	
B. ascendens	
acetaldol	β-butylene glycol, β-hydroxybutyric ac. Binder-Kotrba, 1926
arabinose, dextrose, ethylene glycol, glycerol, glycollic ac., malonic ac., rhamnose	oxalic ac. Banning, 1902
methylethyl-acetaldehyde	l-amyl alc., valeric ac. Neuberg and Simon, 1926

Microorganisms Substrates	Products Authors
B. butylicus (See also *B. amylobacter*)	
dextrose, glycerol	acetic ac., n-butyl alc., n-butyric ac., formic ac., lactic ac. Buchner and Meisenheimer, 1908
dextrose, glycerol, lactic ac., propionic ac.	butyric ac., butyl alc., caproic ac., caprylic ac. Neuberg and Arinstein, 1921
glycerol	n-amyl alc., n-butyl alc., n-propyl alc. Morin, 1887
glycerol, mannitol	butyl alc. Emmerling, 1897
glycerol, mannitol, sucrose	butyl alc., butyric ac., lactic ac. Fitz, 1882
B. butyricus (See *B. amylobacter*)	
B. casei dextrose	lactic ac. Virtanen and Karström, 1928
B. casei lactic ac., succinic ac.	acetic ac., propionic ac. Orla-Jensen, 1904
B. casei E. sucrose	i-lactic ac. Virtanen, Wichmann and Lindström, 1927
B. caucasicus (See *Bact. caucasicum*)	
B. cellulosae dissolvens cellulose	acetic ac., butyric ac., CO_2, ethyl alc., H_2 Khouvine, 1923

Microorganisms Substrates	Products Authors
B. cloacae	
arabinose, galactose, isodulcite, levulose, mannose	acetylmethyl carbinol Harden and Norris, 1912
dextrose, mannitol	acetylmethyl carbinol, 2, 3-butylene glycol Thompson, 1912
dextrose	acetylmethyl carbinol, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac. Scheffer, 1928
dextrose, mannitol	acetic ac., ethyl alc., CO_2, formic ac., lactic ac., succinic ac. Thompson, 1912
B. coli (See also *Bact. coli*) (See also *Bact. coli communis*)	
dextrose	pyruvic ac. Aubel, 1926
dextrose	acetic ac., ethyl alc., l-lactic ac., succinic ac. Grimbert, 1896
dextrose	acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Scheffer, 1928
dextrose, galactose, lactose, mannitol, mannose, sucrose	lactic ac. Péré, 1898
dextrose, mannitol	acetic ac., ethyl alc., formic ac., lactic ac., succinic ac. Thompson, 1912
dextrose	acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Virtanen and Simola, 1927
dextrose	lactic ac. Neuberg and Gorr, 1926

Microorganisms Substrates	Products Authors
B. coli (cont.)	
lactose	acetic ac., ethyl alc., l-lactic ac., succinic ac. Grimbert, 1896
malic ac.	fumaric ac. Quastel and Whetham, 1924
methylglyoxal	lactic ac. Neuberg and Gorr, 1926
pyruvic ac.	acetic ac., formic ac., glycollic ac., lactic ac. Cambier and Aubel, 1922
succinic ac.	fumaric ac. Quastel and Whetham, 1924
sucrose	lactic ac., methylglyoxal Virtanen and Simola, 1927
B. coli communis	
(See also *B. coli*)	
(See also *Bact. coli*)	
(See also *Bact. coli communis*)	
arabinose, dextrose, d-galactose, levulose, mannitol	acetic ac., CO_2, ethyl alc., H_2, lactic ac., succinic ac. Harden, 1901
citric ac.	acetic ac., CO_2, ethyl alc., succinic ac. Grey, 1923
dextrose	acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Grey, 1918
dextrose	acetaldehyde Grey, 1913
dextrose	acetic ac., CO_2, H_2, ethyl alc., lactic ac. Harden, 1899
dextrose	acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Grey, 1920

Microorganisms Substrates	Products Authors
B. coli communis (cont.)	
dextrose	acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Grey and Young, 1921
dextrose	acetic ac., lactic ac., succinic ac. Young, 1924
dextrose, mannitol	acetic ac., CO_2, ethyl alc., H_2, lactic ac., succinic ac. Grey, 1918
dextrose	formic ac. Franzen and Kahlenberg, 1916
dextrose	l-lactic ac. Kimura, 1928
dextrose	CO_2, lactic ac. Goto, 1925
dextrose, gluconic ac., mannitol, saccharic ac.	acetic ac., formic ac., succinic ac. Kay, 1926
formic ac.	CO_2, H_2 Franzen and Kahlenberg, 1916
fumaric ac.	succinic ac. Quastel, Stephenson and Whetham, 1925
glucosamine	d-lactic ac. Kimura, 1928
glycerol	acetic ac., CO_2, ethyl alc., formic ac., lactic ac., succinic ac. Grey, 1923
lactic ac.	pyruvic ac. Quastel, Stephenson and Whetham, 1925
malic ac.	succinic ac., fumaric ac. Quastel and Whetham, 1924
malic ac.	acetic ac., ethyl alc., succinic ac. Grey, 1923
malonic ac.	acetic ac. Grey, 1923

Microorganisms Substrates	Products Authors
B. coli communis (cont.)	
succinic ac.	acetic ac., formic ac., H_2 Grey, 1923
tartaric ac.	acetic ac., ethyl alc., succinic ac. Grey, 1923
B. cylindrosporus (See *B. lactis*)	
B. Delbrücki	
dextrin, dextrose, maltose, sucrose	l-lactic ac. Henneberg, 1903
methylglyoxal	d, l-lactic ac. Henneberg, 1903
phenylglyoxal	d-mandelic ac. Henneberg, 1903
B. dioxyacetonicum	
glycerol	dihydroxyacetone Virtanen and Barlund, 1926
B. dysenteriae, Shiga-Kruse	
dextrose	acetic ac., ethyl alc., formic ac., lactic ac., succinic ac. Scheffer, 1928
dextrose	acetic ac., acetaldehyde, ethyl alc., formic ac., succinic ac. Bergh, 1928
B. ethaceticus	
arabinose	acetic ac., ethyl alc., formic ac., succinic ac. Frankland and MacGregor, 1892
dextrose, mannitol	acetic ac., CO_2, ethyl alc., H_2 Frankland and Lumsden, 1892
glycerol, mannitol	acetic ac., ethyl alc., formic ac., succinic ac. Frankland and Fox, 1889
mannitol	acetic ac., ethyl alc. Frankland, Stanley and Frew, 1891

Microorganisms Substrates	Products Authors
B. ethacetosuccinicus	
lactic ac.	acetic ac., ethyl alc., formic ac. Mazé, 1913
dulcitol, mannitol	acetic ac., CO_2, ethyl alc., H_2, succinic ac. Frankland and Frew, 1892
B. fluorescens	
malic ac.	pyruvic ac. Beijerinck and Folpmers, 1916
B. Freundii	
(See also *Bact. Freundii*)	
dextrose	acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Scheffer, 1928
B. globigii	
(See *B. mesentericus ruber* as a possible synonym)	
B. granulobacter pectinovorum	
(See also *B. amylobacter*)	
(See also *B. butylicus*)	
(See also *B. butyricum*)	
(See also *Cl. pastorianum*)	
B. granulobacter pectinovorum	
arabinose, dextrose galactose, mannitol, starch, xylose	acetic ac., acetone, butyl alc., butyric ac., lactic ac. Speakman, 1923
arabinose, xylose	acetone, butyl alc., CO_2 Peterson, Fred and Schmidt, 1924
B. granulobacter pectinovorum Weizmann	
dextrose	acetic ac., acetylmethyl carbinol, acetone, butyl alc., butyric ac., CO_2, ethyl alc., formic ac., H_2, lactic ac. Donker, 1926

Microorganisms Substrates	Products Authors
B. graveolens (See *B. mesentericus-vulgatus* as a possible synonym)	
B. güntheri dextrose	acetic ac., lactic ac. Hucker, 1928
B. herbicola aurem arabinose, xylose	CO_2 Fred, Peterson and Anderson, 1923
B. industrium acetic ac., dextrose, erythritol, ethylene glycol, isolichenin, mannitol	oxalic ac. Banning, 1902
B. invertenti-acetici sucrose	acetic ac., acetone, ethyl alc., lactic ac. Mezzadroli, 1917
B. invertenti-lattici sucrose	acetic ac., lactic ac. Mezzadroli, 1917
B. Kützingianum arabinose, dextrin, dextrose, ethylene glycol, galactose, glycollic ac., isobutyric ac., isolichenin, lactic ac., malonic ac.	oxalic ac. Banning, 1902
acetic ac.	CO_2, Seifert, 1897
acetic ac.	CO_2, Mayer, 1898
butyl alc.	butyric ac. Seifert, 1897

Microorganisms Substrates	Products Authors
B. Kützingianum (cont.)	
butyl alc.	butyric ac. Mayer, 1898
dextrose	gluconic ac. Seifert, 1897
dextrose	gluconic ac. Mayer, 1898
ethyl alc.	acetic ac. Mayer, 1898
ethylene glycol	glycollic ac. Seifert, 1897
ethylene glycol	glycollic ac. Mayer, 1898
propyl alc.	propionic ac. Mayer, 1898
B. lactis	
i-inositol	acetic ac., ethyl alc., CO_2, succinic ac. Hewitt and Steabben, 1921
B. lactis acidi	
dextrin, dextrose, maltose, sucrose	l-lactic ac. Henneberg, 1903
lactose	d-lactic ac. Henneberg, 1903
B. lactis aerogenes	
acetaldehyde	acetic ac., 2, 3-butylene glycol, succinic ac. Harden and Norris, 1912
adonitol, mannitol	acetylmethyl carbinol, 2, 3-butylene glycol Harden and Norris, 1912
arabinose, dextrose, galactose, isodulcite, mannose	acetylmethyl carbinol, 2, 3-butylene glycol Harden and Norris, 1912
dextrose	acetaldehyde Kumagawa, 1922

Microorganisms Substrates	Products Authors
B. lactis aerogenes (cont.)	
dextrose	acetaldehyde, acetylmethyl carbinol, 2, 3-butylene glycol Neuberg, Nord and Wolff, 1920
dextrose	acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Virtanen and Simola, 1927
dextrose, gluconic ac., mannitol, saccharic ac.,	acetic ac., acetylmethyl carbinol, ethyl alc., formic ac., succinic ac. Kay, 1926
dextrose, mannitol	acetic ac., ethyl alc., formic ac., succinic ac. Thompson, 1912
dextrose	acetylmethyl carbinol, 2, 3-butylene glycol Neuberg, Nord and Wolff, 1920
dextrose, levulose	acetylmethyl carbinol, 2, 3-butylene glycol Walpole, 1911
dextrose, mannitol	acetic ac., acetylmethyl carbinol, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Harden and Walpole, 1906
ethylene glycol, glycerol	2, 3-butylene glycol Harden and Norris, 1912
galactose, gluconic ac., glyceric ac., lactic ac., lactose, levulose, maltose, sucrose	acetaldehyde Nagai, 1923
glycerol	acetic ac., 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Harden and Norris, 1912

Microorganisms Substrates	Products Authors
B. lactic aerogens (cont.)	
glycerol	acetaldehyde Kumagawa, 1922
inositol	acetaldehyde, lactic ac., CO_2, succinic ac. Kumagawa, 1922
lactose	acetic ac., succinic ac. Emmerling, 1900
malic ac.	acetic ac., succinic ac. Emmerling, 1899
xylose	acetic ac., CO_2, ethyl alc., H_2, lactic ac. Fred and Peterson, 1920
B. macerans	
starch, sucrose	acetone, ethyl alc. Bakonyi, 1926
B. of malignant oedema	
dextrose	i-lactic ac., ethyl alc. Kerry and Frankel, 1890
B. mesentericus-ruber	
lactic ac.	2, 3-butylene glycol Lemoigne, 1913
B. mesentericus vulgatus	
dextrose	acetylmethyl carbinol Harden and Norris, 1912
mannitol	acetylmethyl carbinol Harden and Norris, 1912
B. mobilis	
lactic ac.	acetic ac., propionic ac. Jensen, 1904
B. orthobutylicus (Grimbert) (See *Cl. butyricum*) (See *B. Granulobacter butyricum*)	

Microorganisms Substrates	Products Authors
B. oxydans	
acetic ac., dextrose, erythritol, ethylene glycol, glycerol, levulose	oxalic ac. Banning, 1902
B. paratyphoid B	
xylose	acetic ac., butyric ac., CO_2, ethyl alc., formic ac., lactic ac., succinic ac. Fred and Peterson, 1920
B. paratyphosus B	
(See B. *paratyphoid B*)	
B. pasteurianum	
acetic ac.	CO_2 Seifert, 1897
acetic ac.	CO_2 Mayer, 1898
butyl alc.	butyric ac. Seifert, 1897
dextrin, dextrose, ethylene glycol, glycerol, glycollic ac., isobutyric ac., malonic ac., sucrose	oxalic ac. Banning, 1902
dextrose	gluconic ac. Mayer, 1898
dextrose	gluconic ac. Seifert, 1897
ethyl alc.	acetic ac. Mayer, 1898
ethylene glycol	glycollic ac. Seifert, 1897
ethylene glycol	glycollic ac. Mayer, 1898
propyl alc.	propionic ac. Mayer, 1898

Microorganisms Substrates	Products Authors
B. polymyxa	
dextrose	acetic ac., acetylmethyl carbinol, acetone, butyl alc., 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac. Donker, 1926
B. prodigiosus	
dextrose	l-lactic ac. Kimura, 1928
dextrose	formic ac. Franzen and Egger, 1912
glucosamine	l-lactic ac. Kimura, 1928
B. propionicus	
dextrose	lactic ac. Neuberg and Gorr, 1926
methylglyoxal	lactic ac. Neuberg and Gorr, 1926
B. proteus	
dextrose	acetylmethyl carbinol, 2, 3-butylene glycol Lemoigne, 1923
B. proteus vulgatus	
pyruvic ac.	acetic ac., lactic ac., glycollic ac. Cambier and Aubel, 1922
B. pyocyaneus (See also *Bact. pyocyaneus*)	
acetaldehyde	acetic ac. Supniewski, 1923
acetic ac.	formaldehyde, formic ac. Supniewski, 1923
acetone	acetic ac., formic ac. Supniewski, 1923
ethyl alc.	acetaldehyde, acetic ac. Supniewski, 1923

Microorganisms Substrates	Products Authors
B. pyocyaneus (cont.)	
fumaric ac.	acetic ac., pyruvic ac. Quastel, 1924
fumaric ac.	pyruvic ac. Quastel, Stephenson and Whetham, 1925
glycerol	CO_2, glyceric ac., lactic ac. Supniewski, 1923
lactic ac.	acetaldehyde, acetic ac., pyruvic ac. Supniewski, 1923
lactic ac.	pyruvic ac. Quastel, Stephenson and Whetham, 1925
methyl alc.	formic ac. Supniewski, 1923
pyruvic ac.	acetic ac., formic ac. Cambier and Aubel, 1922
pyruvic ac.	lactic ac. Aubel, 1924
succinic ac.	propionic ac. Quastel, 1924
B. spongiosus	
raffinose, sucrose	arabin Ruhland, 1906
B. suaveolens	
starch	acetaldehyde, acetic ac., butyric ac., ethyl alc., formic ac. Sclavo and Gosio, 1891
succinic ac.	fumaric ac. Quastel and Whetham, 1924
B. subtilis	
dextrose	acetylmethyl carbinol Harden and Norris, 1912
dextrose	d- or dl-lactic ac. Kimura, 1928

Microorganisms Substrates	Products Authors
B. subtilis (cont.)	
dextrose	butyric ac., CO_2, lactic ac., H , mannitol Vandevelde, 1884
glucosamine	l-lactic ac. Kimura, 1928
glycerol	butyric ac., lactic ac., succinic ac. Vandevelde, 1884
glycerol	pyruvic ac. Aubel, 1921
lactic ac.	acetylmethyl carbinol, 2, 3-butylene glycol Lemoigne, 1923
mannitol	acetylmethyl carbinol Harden and Norris, 1912
starch	acetic ac., butyric ac., ethyl alc., succinic ac. Fitz, 1878
sucrose	acetylmethyl carbinol, 2, 3-butylene glycol Lemoigne, 1912
B. tarbellicus (See *Thermobacillus tarbellicus*)	
B. tartricus	
dextrose, lactose, maltose, mannitol, sucrose	acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., H_2, lactic ac., succinic ac. Grimbert, 1901
tartaric ac.	acetic ac., CO_2, H_2, succinic ac. Grimbert, 1898
B. thermoamylolyticus	
starch	maltose Coolhaas, 1928
B. thermobutyricus	
dextrose	butyric ac. Coolhaas, 1928

Microorganisms Substrates	Products Authors
B. typhosum	
dextrose	acetic ac., ethyl alc., formic ac., lactic ac., succinic ac. Scheffer, 1928
B. typhosus	
dextrose	acetic ac., formic ac., ethyl alc., lactic ac., succinic ac. Harden, 1901
xylose	acetic ac., butyric ac., ethyl alc., formic ac., lactic ac., succinic ac. Fred and Peterson, 1920
B. vulgatus	
sucrose	gum levan Owen, 1923
xylose	acetone, CO_2 Fred, Peterson and Anderson, 1923
B. welchii	
glycerol	acrolein Humphreys, 1924
B. xylinum	
(See *Acetobacter xylinum*)	
(See also *Bact. xylinum*)	
arabinose, dextrose, glycerol, levulose, rhamnose	oxalic ac. Banning, 1902
dextrose	gluconic ac., ketogluconic ac. Bernhauer and Schön, 1929
glycerol	dihydroxyacetone Bertrand and Sazerac, 1901
glycerol	dihydroxyacetone Brit. patent 269,950
glycerol	dihydroxyacetone Virtanen and Barlund, 1926
glycerol	dihydroxyacetone Bernhauer and Schön, 1928

Microorganisms Substrates	Products Authors
B. xylinum (cont.)	
α-ketoglutaric ac.	succinic ac. Iwatsuru, 1925
mannitol	levulose Hoyer, 1898
methylethylacetaldehyde	i-amyl alc., i-valeric ac. Neuberg and Simon, 1926
sorbitol	sorbose Seifert, 1897
sorbitol	sorbose Hoyer, 1898
sorbitol	sorbose Mayer, 1898
Bact. aceti (See also *Mycoderma aceti*)	
dextrose	gluconic ac. Brown, 1886
ethyl alc.	acetic ac. Brown, 1886
propyl alc.	propionic ac. Brown, 1886
Bact. acidi propionici var. fuscum (See also *Propionibacterium Freudenreichii*) (See also *Bact. acidi propionici a*)	
Bact. acidi propionici a (See also *Bact. acidi propionici var. fuscum*) (See also *Propionibacterium Freudenreichii*)	
Bact. acidi propionici var. fuscum	
dextrose, lactic ac., lactose, pyruvic ac.	acetic ac., propionic ac., succinic ac. Virtanen, 1923

Microorganisms Substrates	Products Authors
Bact. acidi propionici a lactic ac.	acetic ac., propionic ac., CO_2 von Freudenreich and Jensen, 1906
Bact. acidi propionici b (See also *Propionibacterium Jensenii*)	
Bact. acidi propionici b lactic ac.	acetic ac., CO_2, propionic ac. von Freudenreich and Jensen, 1906
Bact. acidi propionici c (See *Propionibacterium Peterssonii*)	
Bact. acidi propionici d (See also *Propionibacterium Shermanii*)	
Bact. acidi propionici d lactose	acetic ac., propionic ac. Sherman and Shaw, 1923
Bact. acidi propionici var. rubrum (See *Propionibacterium rubrum*) (See *Propionibacterium Thonii*)	
Bact. aerogenes (See also *B. lactis aerogenes*)	
Bact. aerogenes glycerol	acetic ac., 2-3 butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Braak, 1928

Microorganisms Substrates	Products Authors
Bact. ascendens	
acetaldol	β-butylene glycol, β-oxybutyric ac. Binder-Kotrba, 1926
phenylglyoxal	d-mandelic ac. Mayer, 1926
Bact. caucasicum	
lactose	lactic ac., methyl glyoxal, pyruvic ac. Kostytschew and Soldatenkov, 1927
Bact. cellaresolvens	
cellulose	acetic ac., butyric ac., cellobiose lactic ac. Groenewege, 1923
Bact. cloacae	
(See *B. cloacae*)	
Bact. coli	
(See also *B. coli*)	
(See also *B. coli communis*)	
(See also *Bact. coli communis*)	
Bact. coli	
galactose, lactose, levulose, malic ac., maltose, sucrose, tartaric ac.	acetaldehyde Nagai, 1923
glycerol	acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Braak, 1928
methyl glyoxal	lactic ac. Neuberg and Gorr, 1925
pyruvic ac.	acetic ac., CO_2, formic ac., glycollic ac., H_2, i-lactic ac., propionic ac. Aubel, 1924

Microorganisms Substrates	Products Authors
Bact. dysenteriae Shiga-Kruse (See *B. dysenteriae*)	
Bact. Freundii	
glycerol	acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., trimethylene glycol, succinic ac. Braak, 1928
Bact. gluconium	
dextrose	gluconic ac. Hermann, 1929
gluconic ac.	5-keto-gluconic ac. Hermann, 1929
levulose	5-keto-gluconic ac. Hermann, 1929
Bact. lactis acidi	
dextrose, lactose, maltose	i-lactic ac. Henneberg, 1903
Bact. lactis aerogenes (See also *B. lactis aerogenes*)	
Bact. lactis aerogenes	
methylglyoxal	d, l-lactic ac. Neuberg and Simon, 1927
phenylglyoxal	l-mandelic ac. Neuberg and Simon, 1927
Bact. opalescens	
cellulose	acetic ac., butyric ac., cellobiose, lactic ac. Groenewege, 1923
Bact. pasteurianum (See also under *Acetobacter*)	

Microorganisms Substrates	Products Authors
Bact. pasteurianum	
d-l-methyl-ethyl acetaldehyde	d-amyl alc., valeric ac. Neuberg and Simon, 1926
methylglyoxal	d-l-lactic ac. Gorr and Perlmann, 1926
Bact. pyocyaneum (See *B. pyocyaneus*) (See *Bact. pyocyaneus*)	
Bact. pyocyaneus (See also *B. pyocyaneus*)	
Bact. pyocyaneus	
dextrose	acetic ac., ethyl alc., formic ac. Aubel, 1921
levulose	acetic ac., ethyl alc., formic ac., lactic ac. Aubel, 1921
Bact. suipestifer	
citric ac.	acetic ac., CO_2, succinic ac. Brown, Duncan and Henry, 1924
Bact. termo	
d-propylene glycol	lactic ac., propionic ac. LeBel, 1881
tartaric ac.	acetic ac., propionic ac., succinic ac. König, 1881
Bact. thermoamylolyticum	
dextrose, sucrose	acetic ac., butyric ac., CO_2, H_2, propionic ac. Coolhaas, 1928
Bact. xylinum (See also *Acetobacter xylinum*)	

Microorganisms Substrates	Products Authors
Citromyces sp.? (cont.)	
sucrose	citric ac., oxalic ac., Butkewitsch, 1922
Citromyces glaber	
arabinose, glycerol, mannitol, sucrose	citric ac., oxalic ac. Butkewitsch, 1923
citric ac.	oxalic ac. Butkewitsch, 1922
dextrose	citric ac. Butkewitsch, 1922
quinic ac.	protocatechuic ac., pyrocatechol Butkewitsch, 1924
sucrose	citric ac., gluconic ac. Butkewitsch, 1927
sucrose	citric ac., oxalic ac. Butkewitsch, 1922
Citromyces lacticus	
dextrose	citric ac. Mazé and Perrier, 1904
Citromyces oxalicus	
dextrose	citric ac. Mazé and Perrier, 1904
Citromyces Pfefferianus	
dextrose	citric ac. Buchner and Wüstenfeld, 1909
sucrose	citric ac., oxalic ac. Butkewitsch, 1922
Citromyces tartricus	
dextrose	citric ac. Mazé and Perrier, 1904
ethyl alc.	citric ac., oxalic ac. Mazé and Perrier, 1904
Cladosporium, sp.?	
phloridzin	dextrose, phloroglucinol Boas, 1916

Microorganisms Substrates	Products Authors
Clostridium Welchii (See *B. Welchii*)	
Diplococcus pneumoniae dextrose	acetic ac., propionic ac. Brieger, 1883
Eberthella dysenteriae (See *B. dysenteriae*)	
Eberthella typhi (See *B. typhosus*) (See *B. typhosum*)	
Encapsulatus pneumoniae (See Friedländer's pneumobacillus)	
Erythrobacillus prodigiosus (See *B. prodigiosus*)	
Escherichia coli (See *B. coli*) (See *Bact. coli*) (See *B. coli communis*) (See *Bact. coli communis*)	
Friedländer's pneumococcus dextrose	acetic ac., ethyl alc., formic ac. Frankland, Stanley and Frew, 1891
mannitol	acetic ac., ethyl alc. Frankland, Stanley and Frew, 1891
Fusarium lini dextrose	CO_2, ethyl alc. Anderson and Willaman, 1922

Microorganisms Substrates	Products Authors
Granulobacter butylicum (See also *B. amylobacter*) (See also *Cl. butyricum*)	
Granulobacter saccharobutyricum dextrose	acetic ac., 2, 3-butylene glycol, butyric ac., CO_2, formic ac., H_2, lactic ac. Donker, 1926
Granulobacterium butylicum starch	ethyl alc., iso-butyl alc., n-butyl alc., iso-propyl alc., propyl alc. Folpmers, 1921
Klebsiella pneumoniae (See Friedländer's pneumobacillus)	
Lactobacillus, sp.? dextrose	lactic ac. Neuberg and Gorr, 1926
methylglyoxal	lactic ac. Neuberg and Gorr, 1926
Lactobacillus arabinosus arabinose	acetic ac., lactic ac. Fred, Peterson and Anderson, 1921
Lactobacillus berolinensis (See *Saccharobacillus pastorianus var. berolinensis*)	
Lactobacillus casei (See *B. casei*)	
Lactobacillus caucasicus (See *Bact. caucasicum*)	

Microorganisms Substrates	Products Authors
Lactobacillus Delbrücki (See *B. Delbrücki*)	
Lactobacillus leichmanni	
dextrose	l-lactic ac. Allgeier and Peterson, 1930
dextrose, galactose, lactose, levulose	l-lactic ac. Fred, Peterson and Stiles, 1925
Lactobacillus pentoaceticus	
arabinose, xylose	acetic ac., lactic ac. Fred, Peterson and Anderson, 1921
dextrose, galactose, lactic ac., mannose	acetic ac., ethyl alc., lactic ac. Peterson and Fred, 1920
levulose	acetic ac., CO_2, lactic ac., mannitol Peterson and Fred, 1920
malic ac., mannitol	acetic ac., lactic ac. Peterson and Fred, 1920
pyruvic ac.	acetic ac., acetaldehyde, CO_2, H_2 Peterson and Fred, 1920
xylose	acetic ac., i-lactic ac. Fred, Peterson and Davenport, 1919
Lactobacillus pentosus	
arabinose, xylose	acetic ac., lactic ac. Fred, Peterson and Anderson, 1921
Lactobacillus, sp.?	
phenylglyoxal	l-mandelic ac. Mayer, 1926
Liquidobacterium prodigiosum (See *B. prodigiosus*)	

Microorganisms Substrates	Products Authors
Micrococcus casei liquefaciens	
lactic ac., succinic ac.	acetic ac., Orla-Jensen, 1904
lactic ac.	acetic ac., propionic ac. Orla-Jensen, 1904
Micrococcus climicus	
quinic ac.	protocatechuic ac. Emmerling and Abderhalden, 1903
Micrococcus oblongus	
dextrose	oxygluconic ac. Boutroux, 1886
Monilia candida	
dextrose	acetaldehyde Cohen, 1920
pyruvic ac.	acetaldehyde Nagayama, 1921
Mucor circinelloides (?)	
dextrin, starch	ethyl alc. Gayon and Dubourg, 1886
Mucor mucedo	
dextrose, sucrose	ethyl alc. Kostytschew and Eliasberg, 1920
sucrose	ethyl alc., succinic ac. Fitz, 1873
Mucor piriformis	
dextrose	citric ac. Wehmer, 1897
Mucor plumbens	
pyruvic ac.	acetaldehyde Nagayama, 1921
Mucor racemosus	
dextrose	acetaldehyde Cohen, 1920

Microorganisms Substrates	Products Authors
Mucor racemosus (cont.)	
dextrose, sucrose	ethyl alc. Kostytschew and Eliasberg, 1920
glycerol	butyl alc., butyric ac., caproic ac., CO_2, ethyl alc., H_2 Fitz, 1876
pyruvic ac.	acetaldehyde Nagayama, 1921
sucrose	ethyl alc. Fitz, 1876
sucrose	ethyl alc., glycerol, succinic ac. Emmerling, 1897
Mucor Rouxii	
dextrose	acetaldehyde Cohen, 1920
pyruvic ac.	acetaldehyde Nagayama, 1921
Mucor stolonifer (See also *Rhizopus nigricans*)	
Mucor stolonifer	
dextrose, sucrose	ethyl alc. Kostytschew and Eliasberg, 1920
Mycoderma aceti (See also *Bact. aceti*)	
Mycoderma aceti	
dextrose	gluconic ac. Boutroux, 1880
d- l-propylene glycol	acetylcarbinol Kling, 1901
2, 3-butylene glycol	acetylmethyl carbinol Kling, 1905

Microorganisms Substrates	Products Authors
Mycoderma sp.?	
dextrose	pyruvic ac. Fernbach and Schoen, 1914
Oidium albicans	
lactic ac.	pyruvic ac. Mazé and Ruot, 1917
Oidium farinosum	
lactic ac.	pyruvic ac. Mazé and Ruot, 1917
Oidium gueraldi	
lactic ac.	pyruvic ac. Mazé and Ruot, 1917
Oidium lactis	
dextrose	acetaldehyde Cohen, 1920
pyruvic ac.	acetaldehyde Nagayama, 1921
Oidium lupuli	
dextrose	acetaldehyde, acetic ac., ethyl alc., succinic ac. Sumiki, 1927
Oidium tenuis	
lactic ac.	pyruvic ac. Mazé and Ruot, 1917
Pectinobacter amylophilum	
starch	acetic ac., butyl alc., formic ac., lactic ac., succinic ac. Makrinov, 1915
Penicillum glaucum	
oleic ac.	keto-stearic ac. Pigulewski and Charik, 1928
sucrose	citric ac., gluconic ac. Butkewitsch, 1927
sucrose	ethyl alc. Kostytschew and Afanassjewa, 1922
sucrose	citric ac., oxalic ac. Butkewitsch, 1922

Microorganisms Substrates	Products Authors
Penicillium luteum	
dextrose	citric ac. Wehmer, 1897
Penicillium purpurogenum	
dextrose	gluconic ac. May, Thom and Church, 1927
dextrose	gluconic ac. Herrick and May, 1928
Pneumobacillus of Friedländer	
arabinose	acetic ac., l-lactic ac. Grimbert, 1896
dulcitol	acetic ac., ethyl alc., succinic ac. Grimbert, 1896
mannitol	acetic ac., ethyl alc., succinic ac. Grimbert, 1896
xylose	acetic ac., ethyl alc., l-lactic ac., succinic ac. Grimbert, 1896
Propionibacterium Freudenreichii (See also *Bact. acidi propionici a*) (See also *Bact. acidi propionici var. fuscum*)	
Propionibacterium Freudenreichii dextrose, glycerol, lactic ac.	acetic ac., CO_2, propionic ac., succinic ac. van Niel, 1928
Propionibacterium Jensenii (See also *Bact. acidi propionici b*)	
Propionibacterium Jensenii dextrose, glycerol, lactic ac., pyruvic ac.	acetic ac., CO_2, propionic ac., succinic ac. van Niel, 1928
Propionibacterium pentosaceum (See *Bacillus acidi propionici*)	

Microorganisms Substrates	Products Authors
Propionibacterium pentosaceum	
arabinose, dextrose, glycerol, lactic ac., starch, xylose	acetic ac., CO_2, propionic ac. Werkman, Hixon, Fulmer and Rayburn, 1929
dextrose, glycerol, lactic ac.	acetic ac., CO_2, propionic ac., succinic ac. van Niel, 1928
Propionibacterium Peterssonii (See also *Bact. acidi propionici c*)	
Propionibacterium Peterssonii	
dextrose, glycerol, lactic ac.	acetic ac., CO_2, propionic ac., succinic ac. van Niel, 1928
Propionibacterium rubrum (See also *Bact. acidi propionici var. rubrum*)	
Propionibacterium rubrum	
dextrose, lactic ac.	acetic ac., CO_2, propionic ac., succinic ac. van Niel, 1928
Propionibacterium Shermanii (See also *Bact. acidi propionici d*)	
Propionibacterium Shermanii	
dextrose, glycerol, lactic ac.	acetic ac., CO_2, propionic ac., succinic ac. van Niel, 1928
Proprionibacterium technicum	
dextrose, glycerol, lactic ac., pyruvic ac., starch	acetic ac., CO_2, propionic ac., succinic ac. van Niel, 1928
Propionibacterium Thönii, (See also *Bact. acidi propionici var. rubrum*)	

Microorganisms Substrates	Products Authors
Propionibacterium Thönii	
dextrose, glycerol, lactic ac.	acetic ac., CO_2, propionic ac., succinic ac. van Niel, 1928
Pseudomonas aeruginosa (See also *B. pyocyaneus*)	
dextrose	acetaldehyde, ethyl alc. Nill, 1927
Rhizopus, sp.?	
dextrose	ethyl alc. Takahashi and Sakaguchi, 1927
glycerol	succinic ac. Takahashi and Sakaguchi, 1927
Rhizopus chinensis	
dextrose	l-lactic ac. Saito, 1911
Rhizopus nigricans (See also *Mucor stolonifer*)	
Rhizopus nigricans	
dextrose, levulose	fumaric ac. Ehrlich, 1912
pyruvic ac.	acetic ac., fumaric ac., lactic ac. Gottschalk, 1925
sucrose, (invert)	fumaric ac., oxalic ac. Butkewitsch, 1927
Saccharobacillus pastorianus var. berolinensis	
dextrin, sucrose	i-lactic ac. Henneberg, 1903
Saccharomyces cerevisiae (See also under yeast)	

Microorganisms Substrates	Products Authors
Sacc. cerevisiae	
arabinose	CO_2, ethyl alc., glyceric aldehyde (?) Abbot, 1926
xylose	CO_2, ethyl alc., glyceric aldehyde (?) Abbot, 1926
Sacc. ellipsoideus	
sucrose	glycerol Adams, 1919
Sacc. Ludwigii	
dextrose	glycogen, CO_2 Gottschalk, 1925
dihydroxyacetone	dextrose Neuberg and Kobel, 1928
Sacc. Saké	
starch	dihexosan, amylobiose Sjöberg, 1927
sucrose	acetaldehyde, acetic ac., ethyl alc., CO_2, glycerol Kumagawa, 1922
Salmonella schottmülleri (See *B. paratyphoid B*)	
Salmonella suipestifer (See *Bact. suipestifer*)	
Sarcina, sp.?	
starch	dextrin Glimm and Grimm, 1928
Sarcina maxima	
levulose	acetic ac., butyric ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Smit, 1928

Microorganisms Substrates	Products Authors
Sarcina ventriculi	
dextrose	acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., formic ac., H_2, lactic ac. Smit, 1928
levulose	acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., H_2, lactic ac. Smit, 1928
Schizomycetes, sp. (?)	
lactic ac.	propionic ac., valeric ac. Fitz, 1880
quinic ac.	acetic ac., formic ac., propionic ac., protocatechuic ac. Loew, 1881
Serratia marcescens (See also *B. prodigiosus*)	
Serratia marcescens	
dextrose	acetic ac., acetylmethyl carbinol, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac. Pederson and Breed, 1928
Sorbose bacterium (See also *Acetobacter sorbose*)	
Sorbose bacterium	
arabinose	arabonic ac. Bertrand, 1898
arabitol	keto-sugar Bertrand, 1898
dextrose	gluconic ac. Bertrand, 1898
erythritol	erythrulose Bertrand, 1898, 1900

Microorganisms Substrates	Products Authors
Sorbose bacterium (cont.)	
galactose	galactonic ac. Bertrand, 1898
α-glucoheptite	α-glucoheptulose Bertrand and Nitzberg, 1928
glycerol	dihydroxyacetone Bertrand, 1898
d-mannitol	levulose Bertrand, 1898
perseitol	keto-sugar Bertrand, 1898
d-sorbitol	sorbose Bertrand, 1898
valemite	keto-sugar Bertrand, 1898
xylose	xylonic ac. Bertrand, 1898
Sterigmatocystis nigra	
sucrose	citric ac., gluconic ac., oxalic ac. Molliard, 1922
Streptococcus brevis	
dextrose	acetic ac., lactic ac. Hucker, 1928
Streptococcus cremoris	
dextrose	acetic ac., lactic ac. Hucker, 1928
Streptococcus fecalis	
dextrose	acetic ac., lactic ac. Hucker, 1928
Streptococcus hemolyticus	
dextrose	acetic ac., lactic ac. Hucker, 1928
Streptococcus hornensis	
sucrose	dextrose Boekhout, 1900

Microorganisms Substrates	Products Authors
Streptococcus inulinareous	
dextrose	acetic ac., lactic ac. Hucker, 1928
Streptococcus lactis	
dextrose	d-lactic ac. Allgeier and Peterson, 1930
dextrose	acetic ac., lactic ac. Hucker, 1928
sucrose	d-lactic ac. Virtanen, Wichmann and Lindström, 1927
Streptococcus mitior	
dextrose	acetic ac., lactic ac. Hucker, 1928
Streptococcus paracitrovorous	
dextrose	acetic ac., lactic ac. Hucker, 1928
Streptococcus pyogenes	
dextrose	acetic ac., lactic ac. Hucker, 1928
Streptococcus stenos	
dextrose	acetic ac., lactic ac. Hucker, 1928
Streptococcus viridans	
dextrose	acetic ac., lactic ac. Hucker, 1928
Termobacterium aceti	
acetic ac., arabinose, dextrose, ethylene glycol, galactose, glycerol, glycollic ac., lactic ac., malonic ac.	oxalic ac. Banning, 1902
Thermobacillus tarbellicus	lactic ac.
sucrose	Guittonneau, 1928
Tyrothrix tenuis	
dextrose, glycerol, mannitol	acetylmethyl carbinol Harden and Norris, 1912

Microorganisms Substrates	Products Authors
Yeast (See also *Sacc. cerevisiae*)	
Yeast	
acetaldehyde	ethyl alc. Kostytschew and Hübbenet, 1912
acetaldehyde	ethyl alc., acetic ac. Kostytschew, 1914
acetaldehyde, sucrose	acetoin Neuberg and Simon, 1925
acetaldol	β-butyleneglycol Neuberg and Kerb, 1918
acetophenone, sucrose	l-phenylmethyl carbinol Neuberg and Nord, 1919
acetylmethyl carbinol	2, 3-butylene glycol Neuberg and Kobel, 1925
aldehydropropionic ac.	succinic ac. Neuberg and Ringer, 1918
benzaldehyde	benzyl alc. Neuberg and Welde, 1914
benzaldehyde	l-phenylacetyl carbinol Neuberg and Ohle, 1922
benzil	benzoin Neuberg and Nord, 1919
benzylpyruvic ac.	phenylpropylaldehyde Rona, 1914
isobutylaldehyde	isobutyl alc. Ohta, 1914
caproicaldehyde	n-hexyl alc. Neuberg and Nord, 1914
chlorobenzaldehyde	acetyl-chlorbenzyl carbinol, p-benzyl alc., chlorobenzoic ac., chlorobenzyl alc. Neuberg and Liebermann, 1921

Microorganisms Substrates	Products Authors
Yeast (cont.)	
cinnamic aldehyde	cinnamic alc. Rona, 1914
citral	geraniol Neuberg and Kerb, 1918
d-citronellaldehyde	citronella oil or alc. Mayer and Neuberg, 1915
dextrose	acetaldehyde Kostytschew, 1912
dextrose, levulose	acetylmethyl carbinol, 2, 3-butylene glycol Kluyver, Donker and Hooft, 1925
dextrose, dioxyacetone, glyceraldehyde	lactic ac. Oppenheimer, 1913
dextrose	glycerol Oppenheimer, 1913
dextrose	lactic ac. Aubel, 1929
dextrose	pyruvic ac. Fernbach and Schoen, 1920
dextrose, sucrose	acetaldehyde, acetic ac., ethyl alc., glycerol Neuberg and Hirsch, 1919
dextrose with brucine	brucine pyruvate Traetta-Mosca, 1927
α. α. dichloracetone	α. α. dichlorpropyl alc. Sen, 1924
dihydroxymaleic ac.	CO_2, glycollicaldehyde Neuberg and Schwenk, 1915
enanthol	n-heptyl alc. Ohta, 1914
ethyl alc.	acetaldehyde Trillat and Sauton, 1908
ethyl disulfide	ethyl mercaptan Neuberg and Schwenk, 1915

Microorganisms Substrates	Products Authors
Yeast (cont.)	
formaldehyde	methyl alc. Neuberg and Welde, 1914
furfural	furfuryl alc. Lintner and Liebig, 1911
furfural	furyltrimethyleneglycol Lintner and Liebig, 1913
galactose	acetaldehyde, glycerol Tomita, 1921
glyceric ac.	acetaldehyde, acetic ac., CO_2, ethyl alc. Lebedev, 1918
glyceric aldehyde, pyruvic ac.	acetaldehyde, acetic ac., ethyl alc. Lebedev and Polonski, 1917
glycerol, mannitol	ethyl alc., CO_2 Kostytschew and Faermann, 1928
glycerol	ethyl alc. Neuberg and Kerb, 1913
glycolaldehyde	ethylene glycol Neuberg and Schwenk, 1915
glyoxylic ac.	acetaldehyde, CO_2 Lebedev, 1918
hydroxyfumaric ac.	acetaldehyde, CO_2 Mayer, 1913
hydroxypyruvic ac.	CO_2, glycolaldehyde Neuberg and Kerb, 1913
α-ketobutyric ac.	ethyl alc., propyl alc. Neuberg and Kerb, 1914
α-ketobutyric ac.	propionaldehyde Neuberg and Kerb, 1912
α-ketobutyric ac.	propionaldehyde, propyl alc. Neuberg and Kerb, 1913
α-keto-n-caprioc ac.	n-amyl alc., CO_2, o-methyl-cyclohexanol, n-valeraldehyde Sen, 1923

Microorganisms Substrates	Products Authors
Yeast (cont.)	
ketoglutaric ac.	CO_2, succinic ac. Neuberg and Ringer, 1914
α-ketoisovaleric ac.	isobutyl aldehyde Sen, 1923
lactic ac.	ethyl alc., pyruvic ac. Kayser, 1923
lactose	acetaldehyde Trillat, 1908
levulose	acetylmethyl carbinol, 2, 3-butylene glycol Kluyver and Donker, 1924
malic ac.	lactic ac. Lebedev and Russ, 1916
mannose	ethyl alc. Mezzadroli, 1918
methoxybenzaldehyde	methoxybenzoic ac. Neuberg and Liebermann, 1921
methyl-benzoyl-carbinol+dextrose	methyl-phenyl-ethylene glycol Neuberg and Komarewsky, 1927
methylethyl ketone+sucrose	d-methylethyl carbinol Neuberg and Nord, 1919
methylethyl pyruvic ac.	amyl alc., methyl-ethyl acetaldehyde, valeric ac. Neuberg and Peterson, 1914
methyl-α-chlorethyl ketone	methyl-α-chlorethyl alc. Santomauro, 1924
methyl glyoxal	d-lactic ac. Neuberg and Kobel, 1927, 1929
methyl glyoxal	d-l-lactic ac. Neuberg, 1913
methyl glyoxal	lactic ac. Dakin and Dudley, 1913

Microorganisms Substrates	Products Authors
Yeast (cont.)	
methyl-n-hexyl ketone	d-methyl hexyl carbinol Neuberg and Nord, 1919
methylnonyl ketone	d-methyl nonyl carbinol Neuberg and Nord, 1919
methyl-n-propyl ketone+ sucrose	methyl-n-propyl carbinol Neuberg and Nord, 1919
oxalacetic ac.	acetaldehyde, acetone, CO_2 Neuberg and Gorr, 1925
oxalacetic ac.	acetaldehyde, CO_2 Neuberg and Kerb, 1913
oxalacetic ac.	acetylmethyl carbinol, 2, 3-butylene glycol, malic ac. Neuberg and Gorr, 1924
phenylacetaldehyde	phenylethyl alc. Neuberg and Welde, 1914
phenylglyoxal	mandelic ac. Dakin and Dudley, 1913
phenylglyoxalic ac.	benzaldehyde Binder-Kotrba, 1926
pyruvic ac.	acetaldehyde, CO_2 Gottschalk, 1923
pyruvic ac.	acetaldehyde Neuberg and Reinfürth, 1920
pyruvic ac.	acetylmethyl carbinol Hirsch, 1922
pyruvic ac.	acetaldehyde, CO_2 Neuberg and Kerb, 1912
pyruvic ac.	acetylmethyl carbinol, CO_2 Neuberg and May, 1923
pyruvic ac.	aldol Neuberg, 1912
pyruvic ac.	ethyl alc. Neuberg and Kerb, 1913
pyruvic ac., sucrose	acetaldehyde Paris, 1922

Microorganisms Substrates	Products Authors
Yeast (cont.)	
sucrose	acetaldehyde, ethyl alc., glycerol Gehle, 1922
sucrose	acetaldehyde, ethyl alc., glycerol Zerner, 1920
sucrose	acetaldehyde, glycerol Neuberg and Reinfürth, 1918
sucrose	acetic ac., malic ac., succinic ac. Kostytschew and Frey, 1925
sucrose	2, 3-butylene glycol Henninger, 1888
sucrose	glycerol Buchner and Meisenheimer 1906
sucrose	glycerol Abderhalden and Stix, 1922
sucrose	glycerol Connstein and Ludecke, 1919
sucrose	glycerol Tomoda, 1928
sucrose	lactic ac. Fernbach and Schoen, 1923
sucrose	l-malic ac. Dakin, 1924
sucrose	pyruvic ac. Fernbach and Schoen, 1913
sucrose	pyruvic ac. Klein and Fuchs, 1929
d-tartaric ac.	butyric ac., lactic ac., propionic ac., succinic ac. Karczag, 1912
thioacetaldehyde	ethylmercaptan Neuberg and Nord, 1914
o-tolyl aldehyde	o-tolylacetyl carbinol Behrens and Ivanoff, 1926
p-tolyl aldehyde	p-tolylacetyl carbinol Behrens and Ivanoff, 1926

Microorganisms Substrates	Products Authors
Yeast (cont.)	
trichloracetaldehyde	trichlorethylalcohol Lintner and Lüers, 1913
α, α, β-trichlorbutyl aldehyde	2, 2, 3-trichlorbutanol Rosenfeld, 1925
valeraldehyde	amyl alc. Neuberg and Steenbock, 1914
n-valeraldehyde	n-amyl alc. Neuberg and Nord, 1914
Zygosaccharomyces major	
sucrose	acetaldehyde, acetic ac., CO_2, ethyl alc., glycerol Kumagawa, 1922
Zygosaccharomyces salsus	
sucrose	acetaldehyde, acetic ac., CO_2, ethyl alc., glycerol Kumagawa, 1922

CHAPTER II

INDEX TO ORGANIC (NON-NITROGENOUS) SUBSTRATES

CHAPTER II

TABLE TWO

INDEX TO ORGANIC (NON-NITROGENOUS) SUBSTRATES

Substrates Products	Microorganisms Authors
Acetaldehyde	
acetic ac.	*B. pyocyaneus* Supniewski, 1923
acetylmethyl carbinol	yeast Neuberg and Simon, 1925
acetic ac., ethyl alc.	yeast Kostytschew, 1914
acetic ac., 2, 3-butylene-glycol, succinic ac.	*B. lactis aerogenes* Harden and Norris, 1912
ethyl alc.	yeast Kostytschew and Hübbenet, 1912
Acetaldol	
β, butylene glycol, β, hydroxy-butyric ac.	*Bact. ascendens* Binder-Kotrba, 1926
β, butylene glycol	yeast Neuberg and Kerb, 1918
Acetic ac.	
formaldehyde, formic ac.	*B. pyocyaneus* Supniewski, 1923
glycollic ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
oxalic ac.	*Asp. niger* Wehmer, 1891

Substrates Products	Microorganisms Authors
Acetic ac. (cont.)	
oxalic ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
oxalic ac.	*Asp. niger* Raistrick and Clark, 1919
oxalic ac.	*B. industrium*, *B. oxydans*, *Termobacterium aceti* Banning, 1902
Acetoin See acetylmethyl carbinol	
Acetone acetic ac., formic ac.	*B. pyocyaneus* Supniewski, 1923
Acetonedicarboxylic ac. oxalic ac.	*Asp. niger* Walker, Subramaniam and Challenger, 1927
Acetophenone+sucrose l-phenylmethyl carbinol	yeast Neuberg and Nord, 1919
Acetylmethyl carbinol 2, 3-butylene glycol	yeast Neuberg and Kobel, 1925
Adonitol acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Harden and Norris, 1912
d-adoninulose	*Acetobacter suboxydans* Visser 't Hooft, 1925
Aldehydropropionic ac. succinic ac.	yeast Neuberg and Ringer, 1918

Substrates Products	Microorganisms Authors
Arabinose	
acetic ac., acetone, butyl alc., butyric ac., lactic ac.	*B. granulobacter pectionovorum* Speakman, 1923
acetic ac., CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. coli communis* Harden, 1901
acetic ac., CO_2, propionic ac.	*Propionibacterium pentosaceum* Werkman, Hixon, Fulmer and Rayburn, 1929
acetic ac., ethyl alc., formic ac. succinic ac.	*B. ethaceticus* Frankland and MacGregor, 1892
acetic ac., lactic ac.	*Lactobacillus pentosus*, *Lactobacillus pentoaceticus*, *Lactobacillus arabinosus* Peterson, Fred and Anderson, 1921
acetic ac., l-lactic ac.	Pneumobacillus of Friedländer Grimbert, 1896
acetone, butyl alc., CO_2	*B. granulobacter pectinovorum* Peterson, Fred and Schmidt, 1924
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetylmethyl carbinol, 2, 3-butylene glycol	*B. cloacae* Harden and Norris, 1912
acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Harden and Norris, 1912
arabonic ac.	Sorbose bacterium Bertrand, 1898
citric ac.	Citromyces, sp.? Wehmer, 1913
citric ac., oxalic ac.	*Asp. niger* Amelung, 1927
citric ac., oxalic ac.	*Asp. niger*, *Citromyces glaber* Butkewitsch, 1923

Substrates Products	Microorganisms Authors
Arabinose (cont.)	
CO_2	*B. heribicola aureum* Fred, Peterson and Anderson, 1923
CO_2, ethyl alc., glyceric ald. (?)	*Sacc. cerevisiae* Abbott, 1926
fumaric ac., citric ac.	*Asp. fumaricus* Schreyer, 1928
gluconic ac.	*Asp. niger* Bernhauer, 1928
oxalic ac.	*B. aceti*, *B. acetigenum*, *B. acetosum*, *B. ascendens*, *B. Kützingianum*, *B. xylinum*, *Termobacterium aceti* Banning, 1902
Arabitol	
keto-pentose	sorbose bacterium Bertrand, 1898
Benzaldehyde	
benzyl alc.	yeast Neuberg and Welde, 1914
phenyl-acetyl carbinol	yeast Neuberg and Ohle, 1922
Benzil	
benzoin	yeast Neuberg and Gorr, 1919
Benzylpyruvic ac.	
phenylpropyl aldehyde	yeast Rona, 1914
Butyl alc.	
butyric ac.	*B. Kützingianum*, *B. Pasteurianum* Seifert, 1897
butyric ac.	*Acetobacter melanogenum* Visser't Hooft, 1925

Substrates Products	Microorganisms Authors
2, 3-Butylene glycol	
acetone	*Acetobacter suboxydans* *Acetobacter xylinum* Visser't Hooft, 1925
acetylmethyl carbinol	Sorbose bacteria, *Mycoderma aceti* Kling, 1905
Butyric ac.	
β-hydroxybutyric ac., acetoacetic ac., acetone	*Asp. niger* Coppock, Subramaniam and Walker, 1928
Caproicaldehyde	
n-hexyl alc.	yeast Neuberg and Nord, 1914
Cellulose	
acetic ac., butyric ac., CO_2, ethyl alc., H_2	*Clostridium thermocellum* Viljoen, Fred and Peterson, 1926
acetic ac., butyric ac., CO_2, ethyl alc., H_2	*B. cellulosae dissolvens* Khouvine, 1923
acetic ac., butyric ac., lactic ac., cellobiose	*Bact. cellaresolvens* *Bact. opalescens* Groenewege, 1923
Chloral	
(See trichloracetaldehyde)	
Chlorobenzaldehyde	
chlorobenzoic ac., chlorobenzyl alc.	yeast Neuberg and Liebermann, 1921
Cinnamic ac.	
styrol	*Asp. niger* Herzog and Ripke, 1908
Cinnamic aldehyde	
cinnamic alc.	yeast Rona, 1914

Substrates Products	Microorganisms Authors
Citral	
geraniol	yeast Neuberg and Kerb, 1918
Citric ac.	
acetic ac., CO_2, succinic ac.	*B. suipestifer* Brown, Duncan and Henry, 1924
acetic ac., CO_2, ethyl alc., succinic ac.	*B. coli communis* Grey, 1923
acetone, glyoxylic ac., malonic ac., oxalic ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
acetonedicarboxylic ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
glycollic ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
oxalic ac.	*Citromyces glaber* Butkewitsch, 1922
oxalic ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
α-Citronell aldehyde	
α-citronella oil or alc.	yeast Mayer and Neuberg, 1915
Dextrin	
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
ethyl alc.	*Mucor circinelloides* (?) Gayon and Dubourg, 1886

Substrates Products	Microorganisms Authors
Dextrin (cont.)	
oxalic ac.	*Asp. niger* Elfving, 1919
oxalic ac.	*B. acetosum* *B. Kützingianum* *B. Pasteurianum* Banning, 1902
Dextrose	
acetaldehyde	*B. coli communis* Grey, 1913
acetaldehyde	*Asp. cellulosae* *Monilia candida* *Mucor racemosus* *Mucor rouxii* *Oidium lactis* Cohen, 1920
acetaldehyde	*B. lactis aerogenes* Kumagawa, 1922
acetaldehyde	yeast Kostytschew, 1912
acetaldehyde, acetic ac., ethyl alc., glycerol	yeast Neuberg and Hirsch, 1919
acetaldehyde, acetic ac., ethyl alc., succinic ac.	*Oidium lupuli* Sumiki, 1927
acetaldehyde, acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Neuberg, Nord and Wolff, 1920
acetaldehyde, acetic ac., ethyl alc., formic ac., succinic ac.	*B. dysenteriae*, Shiga-Kruse Bergh, 1928
acetic ac.	*B. coli* Scheffer, 1928
acetic ac., acetone, butyl alc., butyric ac., lactic ac.	*B. granulobacter pectinovorum* Speakman, 1923

Substrates Products	Microorganisms Authors
Dextrose (cont.)	
acetic ac., acetone, 2, 3-butylene glycol, butyric ac., CO_2, ethyl alc., formic ac., H_2	*Cl. pasteurianum* Donker, 1926
acetic ac., acetone, ethyl alc., formic ac., lactic ac.	*B. acetoethylicum* Arzberger, Peterson and Fred, 1920
acetic ac., acetylmethyl carbinol, acetone, butyl alc., 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac.	*B. polymyxa* Donker, 1926
acetic ac., acetylmethyl carbinol, acetone, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac.	*B. acetoethylicum* Donker, 1926
acetic ac., acetylmethyl carbinol, acetone, butyl alc., butyric ac., CO_2, ethyl alc., formic ac., H_2, lactic ac.	*B. granulobacter pectinovorum* (Weizmann) Donker, 1926
acetic ac., acetylmethyl carbinol, 2, 3-butylene glycol, ethyl alc., formic ac., lactic ac., succinic ac.	*B. lactis aerogenes* Harden and Walpole, 1906
acetic ac., acetylmethyl carbinol, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*B. aerogenes* Scheffer, 1928
acetic ac., acetylmethyl carbinol, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*Serratia marcescens* Pederson and Breed, 1928
acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. tartricus* Grimbert, 1901

Substrates Products	Microorganisms Authors
Dextrose (cont.)	
acetic ac., 2, 3-butylene glycol, butyric ac., CO_2, formic ac., H_2, formic ac.	*Granulobacter saccharo-butyricum* Donker, 1926
acetic ac., butyric ac.	*Cl. pasteurianum* Winogradsky, 1902
acetic ac., butyric ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*Sarcina maxima* Smit, 1928
acetic ac., butyric ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*Sarcina ventriculi* Smit, 1928
acetic ac., butyric ac., lactic ac.	*B. butylicus* Buchner and Meisenheimer, 1908
acetic ac., CO_2, ethyl alc., gluconic ac.	*Acetobacter Sp.*? Söhngen, 1914, 1915
acetic ac., CO_2, ethyl alc., H_2	*B. ethaceticus* Frankland and Lumsden, 1892
acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*B. coli communis* Grey and Young, 1921
acetic ac,. CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*B. Freundii* Scheffer, 1928
acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*B. coli communis* Grey, 1920
acetic ac., CO_2, ethyl alc., formic ac., lactic ac., succinic ac.	*B. cloacae*, *B. coli*, *B. lactis aerogenes* Thompson, 1912
acetic ac., CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. coli communis* Harden, 1901

Substrates Products	Microorganisms Authors
Dextrose (cont.)	
acetic ac., CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. coli communis* Grey, 1918
acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*B. aerogenes*, *B. coli* Virtanen and Simola, 1927
acetic ac., CO_2, ethyl alc., formic ac., lactic ac., succinic ac.	*B. coli communis* Kay, 1926
acetic ac., CO_2, ethyl alc., H_2, lactic ac.	*B. coli communis* Harden, 1899
acetic ac., CO_2, ethyl alc., formic ac., H_2	Friedlander's pneumococcus Frankland, Stanley and Frew, 1891
acetic ac., CO_2, propionic ac., succinic ac.	*Propionibacterium Freudenreichii* *Propionibacterium Jensenii* *Propionibacterium pentosaceum* *Propionibacterium Peterssonii* *Propionibacterium rubrum* *Propionibacterium Shermanii* *Propionibacterium technicum* *Propionibacterium Thönii* Van Niel, 1928
acetic ac., ethyl alc.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
acetic ac., ethyl alc., formic ac.	*Bact. pyocyaneus* Aubel, 1921
acetic ac., ethyl alc., formic ac.	*B. typhosus* Harden, 1901
acetic ac., ethyl alc., formic ac., lactic ac., succinic ac.	*B. typhosum* Scheffer, 1928
acetic ac., ethyl alc., succinic ac.	Friedländer's pneumobacillus Grimbert, 1896

Substrates Products	Microorganisms Authors
Dextrose (cont.)	
acetic ac., ethyl alc., formic ac., lactic ac., succinic ac.	*B. dysenteriae*, Shiga-Kruse Scheffer, 1928
acetic ac., ethyl alc., l-lactic ac.	*B. coli* Grimbert, 1896
acetic ac., lactic ac., succinic ac.	*B. coli communis* Young, 1924
acetic ac., oxalic ac.	*Asp. niger* Heinze, 1903
acetic ac., propionic ac., succinic ac.	*B. acidi propionici var. fuscum* Virtanen, 1923
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetone, ethyl alc., pyruvic ac.	*B. acetoethylicum* Speakman, 1925
acetylmethyl carbinol	*B. mesentericus vulgatus* *B. subtilis* *Tyrothrix tenuis* Harden and Norris, 1912
acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., formic ac., lactic ac., succinic ac.	*B. lactis aerogenes* Kay, 1926
acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Walpole, 1911
acetylmethyl carbinol, 2, 3-butylene glycol	*B. cloacae* Thompson, 1912
acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Harden and Norris, 1912
acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Neuberg, Nord, and Wolff, 1920
acetylmethyl carbinol, 2, 3-butylene glycol	*B. proteus* Lemoigne, 1923

Substrates Products	Microorganisms Authors
Dextrose (cont.)	
acetylmethyl carbinol, 2, 3-butylene glycol	yeast Kluyver, Donker and Hooft, 1925
acetylmethyl carbinol, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac.	*B. cloacae* Scheffer, 1928
butyric ac.	*Bact. thermobutyricus* Coolhaas, 1928
butyric ac., butyl alc., caproic ac., caprylic ac.	*B. butylicus* Neuberg and Arinstein, 1921
butyric ac., CO_2, H_2, mannitol	*B. subtilis* Vanderwelde, 1884
citric ac.	*Asp. fumaricus* Schreyer, 1928
citric ac.	*Citromyces citricus* *Citromyces lacticus* *Citromyces tartricus* *Citromyces oxalicus* Mazé and Perrier, 1904
citric ac.	*Citromyces, sp.*? Martin, 1916
citric ac.	*Asp. niger* Bernhauer, 1928
citric ac.	*Citromyces citricus* Buchner and Wüstenfeld, 1909
citric ac.	*Citromyces Pfefferianus* Buchner and Wüstenfeld, 1909
citric ac.	*Mucor piriformis* Wehmer, 1897
citric ac.	*Pen. luteum* Wehmer, 1897

Substrates Products	Microorganisms Authors
Dextrose (cont.)	
citric ac., gluconic ac.	*Asp. niger*, *Asp. cinnamoneus*, *Asp. fuscus* Falck and Kapur, 1924
citric ac., oxalic ac.	*Asp. niger* Wehmer, 1924
citric ac., oxalic ac.	*Asp. niger* Amelung, 1927
citric ac., oxalic ac.	*Asp. niger* Elfving, 1919
citric ac., oxalic ac.	*Citromyces glaber* Butkewitsch, 1922
CO_2, ethyl alc.	*Fusarium lini* Anderson and Willaman, 1922
ethyl alc.	*Mucor mucedo* *Mucor racemosus* *Mucor stolonifer* Kostytschew and Eliasberg, 1920
ethyl alc.	yeast Rimini, 1926
ethyl alc.	*Rhizopus*, sp.? Takahashi and Sakaguchi, 1927
ethyl alc., CO_2	*Asp. niger* Kostytschew, 1907
formic ac.	*B. prodigiosus* Franzen and Egger, 1912
formic ac., CO_2, H_2	*B. coli communis* Franzen and Kahlenberg, 1916
fumaric ac.	*Rhizopus nigricans* Ehrlich, 1912
gluconic ac.	*Asp. niger* Bernhauer, 1928

Substrates Products	Microorganisms Authors
Dextrose (cont.)	
gluconic ac.	*Bact. aceti* Brown, 1886
gluconic ac.	*B. Kützingianum* *B. Pasteurianum* Seifert, 1897
gluconic ac.	sorbose bacterium Bertrand, 1898
gluconic ac.	*Pen. purpurogenum* May, Thom and Church, 1927
gluconic ac.	*Mycoderma aceti* Boutroux, 1880
gluconic ac.	*Pen. purpurogenum* Herrick and May, 1928
gluconic ac.	*Asp. niger* Müller, 1925
gluconic ac.	*Acetobacter*, sp.? *Bact. aceti viscosum* Day and Walker, 1913
gluconic ac.	*Bact. acetigenium* *Bact. acetosum* *Bact. oxydans* Henneberg, 1909
gluconic ac., keto-gluconic ac.	*B. xylinum* Bernhauer and Schön, 1929
glycerol	yeast Oppenheimer, 1913
lactic ac.	*B. casei* Virtanen and Karström, 1928
lactic ac.	*B. coli* Péré, 1898
lactic ac.	*Lactobacillus leichmanni* Fred, Peterson and Stiles, 1925
l-lactic ac.	*Lactobacillus leichmanni* Allgeier and Peterson, 1930

Substrates Products	Microorganisms Authors
Dextrose (cont.)	
lactic ac.	*Lactobacillus, sp.*? Neuberg and Gorr, 1926
d-lactic ac.	*Clostridium thermocellum* Peterson, Fred and Martin, 1926
d-lactic ac.	*Strept. lactis* Allgeier and Peterson, 1930
lactic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
lactic ac.	*B. propionicus* Neuberg and Gorr, 1926
lactic ac.	yeast Aubel, 1929
lactic ac., CO_2	*B.coli communis* Goto, 1925
lactic ac., ethyl alc.	B. of malignant oedema King and Frankel, 1890
l-lactic ac.	*Rhizopus chinensis* Saito, 1911
lactic ac.	yeast Oppenheimer, 1913
oxalic ac.	*Asp. niger* Wehmer, 1891, 1897
oxalic ac.	*B. aceti, B. Kützingianum* *B. acetigenum, B. acetosum* *B. ascendens, B. industrium* *B. oxydans, B. Pasteurianum* *B. xylinium, Termobacterium aceti* Banning, 1902
oxygluconic ac.	*Micrococcus oblongus* Boutroux, 1886
propionic. ac.	*Diplococcus pneumoniae* Brieger, 1883
pyruvic ac.	yeast Traetta-Mosca, 1927

Substrates Products	Microorganisms Authors
Dextrose (cont.)	
pyruvic ac.	*Mycoderma*, sp.? Fernbach and Schoen, 1914
pyruvic ac.	*B. coli* Aubel, 1926
pyruvic ac.	yeast Fernbach and Schoen, 1920
α, α, dichloroacetone	
α,α-di-chloropropylalcohol	yeast Sen, 1924
Dihydroxyacetone	
dextrose	*Sacc. ludwigii* Neuberg and Kobel, 1928
lactic ac.	yeast Oppenheimer, 1913
Dihydroxymaleic ac.	
CO_2, glycollic aldehyde	yeast Neuberg and Schwenk, 1915
Dulcitol	
acetic ac., CO_2, ethyl alc., H_2, succinic ac.	*B. ethoacetosuccinicus* Frankland and Frew, 1892
Enanthol	
n-heptyl alc.	yeast Ohta, 1914
Erythritol	
erythrulose	sorbose bacterium Bertrand, 1898, 1900
erythrose	*Acetobacter suboxydans* Kluyver and deLeeuw, 1924
oxalic ac.	*B. aceti*, *B. acetosum* *B. industrium*, *B. oxydans* Banning, 1902

Substrates Products	Microorganisms Authors
Ethyl alc.	
acetaldehyde	yeast Trillat and Sauton, 1908
acetaldehyde, acetic ac.	*B. pyocyaneus* Supniewski, 1923
acetic ac.	*Bact. aceti* Brown, 1886
acetic ac.	*Acetobacter sp.*? Knieriem and Mayer, 1872
acetic ac.	*B. Kützingianum* *B. Pasteurianum* Mayer, 1898
acetic ac.	*Acetobacter sp.*? *B. aceti* (Hansen) Buchner and Gaunt, 1906
acetic ac.	*Acetobacter sp.*? Söhngen, 1913
acetic ac.	*Acetobacter sp.*? *Bact. aceti viscosum* Day and Baker, 1913
acetic ac.	*Acetobacter suboxydans* Visser't Hooft, 1925
citric ac., oxalic ac.	*Citromyces citricus* *Citromyces tartricus* Mazé and Perrier, 1904
Ethyl disulfide	
ethyl mercaptan	yeast Neuberg and Schwenk, 1915
Ethylene glycol	
2, 3-butylene glycol	*B. lactis aerogenes* Harden and Norris, 1912
glycollic ac.	*Acetobacter melanogenum* Visser't Hooft, 1925 *B. Kützingianum* Seifert, 1897 *B. Pasteurianum* Mayer, 1898

Substrates Products	Microorganisms Authors
Ethylene glycol (cont.)	
oxalic ac.	*B. aceti*, *B. acetosum* *B. ascendens*, *B. industrium* *B. Kützingianum*, *B. oxydans* *B. Pasteurianum* *Termobacterium aceti* Banning, 1902
Formaldehyde	
methyl alc.	yeast Neuberg and Welde, 1914
Formic ac.	
CO_2, H_2	*B. coli communis* Franzen and Kahlenberg, 1916
Fumaric ac.	
acetic ac., pyruvic ac.	*B. pyocyaneus* Quastel, 1924
l-malic ac.	*Asp. niger* Challenger and Klein, 1929
malic ac.	*B. coli* Quastel and Whetham, 1924
oxalic ac.	*Asp. niger* Raistrick and Clark, 1919
pyruvic ac.	*B. pyocyaneus* Quastel, 1924
succinic ac.	*B. coli communis* Quastel, Stephenson and Whetham, 1925
Furfural	
furfuryl alc.	yeast Lintner and Liebig, 1911
furyltrimethylene glycol	yeast Lintner and Liebig, 1913
Galactose	
acetaldehyde	*Bact. coli*, *B. lactis aerogenes* Nagai, 1923

Substrates Products	Microorganisms Authors
Galactose (cont.)	
acetaldehyde, CO_2, glycerol	yeast Tomita, 1921
acetic ac., acetone, butyl alc., butyric ac., lactic ac.	*B. granulobacter pectinovorum* Speakman, 1923
acetic ac., CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. coli communis* Harden, 1901
acetic ac., ethyl alc., lactic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Harden and Norris, 1912
citric ac., oxalic ac.	*Asp. niger* Amelung, 1927
fumaric ac., citric ac.	*Asp. fumaricus* Schreyer, 1928
galactonic ac.	sorbose bacterium Bertrand, 1898
lactic ac.	*B. coli* Péré, 1898
oxalic ac.	*B. Kützingianum* *Termobacterium aceti* Banning, 1902
α-Glucoheptite	
α-glucoheptulose	sorbose bacterium Bertrand and Nitzberg, 1928
Gluconic ac.	
acetaldehyde	*B. lactis aerogenes* Nagai, 1923
acetic ac., ethyl alc., formic ac. lactic ac., succinic ac.	*B. coli communis* Kay, 1926
acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., formic ac., lactic ac., succinic ac.	*B. lactis aerogenes* Kay, 1926

Substrates Products	Microorganisms Authors
Gluconic ac. (cont.)	
citric ac.	*Asp. fumaricus* Schreyer, 1925, 1928
citric ac., saccharic ac.	*Asp. niger* Walker, Subramaniam and Challenger, 1927
dihydroxyacetone, ethyl alc.	*Acetobacter sp.*? Söhngen, 1914, 1915
oxalic ac.	*Asp. niger* Butkewitsch, 1923
oxygluconic ac.	*Acetobacter suboxydans* Kluyver and deLeeuw, 1921
Glyceraldehyde	
lactic ac.	yeast Oppenheimer, 1913
Glyceric ac.	
acetaldehyde	*B. lactis aerogenes* Nagai, 1923
acetaldehyde	yeast Lebedev and Polonski, 1916
acetaldehyde, acetic ac., CO_2, ethyl alc.	yeast Lebedev, 1918
citric ac.	*Asp. fumaricus* Schreyer, 1928
Glycerol	
acetaldehyde	*B. lactis aerogenes* Kumagawa, 1922
acetic ac., butyl alc., butyric ac.	*Amylobacter butylicus* Duclaux, 1895
acetic ac., 2, 3-butylene glycol, CO_2, ethyl alc., formic ac. H_2, lactic ac., succinic ac.	*B. lactis aerogenes* Harden and Norris, 1912
acetic ac., 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*Bact. aerogenes* Braak, 1928

Substrates Products	Microorganisms Authors
Glycerol (cont.)	
acetic ac., CO_2, ethyl alc., formic ac., H_2 lactic ac., succinic ac., trimethylene glycol	*Bact. Freundii* Braak, 1928
acetic ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*Bact. coli* Braak, 1928
acetic ac., CO_2, propionic ac., succinic ac.	*Propionibacterium pentosaceum* Van Niel, 1928
acetic ac., CO_2, propionic ac.	*Propionibacterium Thonii* *Propionibacterium technicum* *Propionibacterium Shermanii* *Propionibacterium Peterssonii* *Propionibacterium Jensenii* Van Niel, 1928
acetic ac., ethyl alc., formic ac., succinic ac.	*B. ethaceticus* Frankland and Fox, 1889
acetic ac., CO_2, ethyl alc., formic ac., lactic ac., succinic ac.	*B. coli* Grey, 1923
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetylmethyl carbinol	*Tyrothrix tenuis* Harden and Norris, 1912
acrolein	*B. Welchii* Humphreys, 1924
acrylaldehyde	*B. amaracrylus* Voisenet, 1918
n-amyl alc., n-butyl alc., n-propyl alc.	*B. butylicus* Morin, 1887
butyl alc.	*B. butylicus* Emmerling, 1897
butyl alc., butyric ac., lactic ac.	*B. butylicus* Fitz, 1882
butyl alc., butyric ac., caproic ac., CO_2, ethyl alc., H_2	*Mucor racemosus* Fitz, 1876

Substrates Products	Microorganisms Authors
Glycerol (cont.)	
n-butyl alc., formic ac., lactic ac.	*B. butylicus* Buchner and Meisenheimer, 1908
2, 3-butylene glycol	*B. lactis aerogenes* Harden and Norris, 1912
butyl alc., butyric ac., caproic ac., caprylic ac.	*B. butylicus* Neuberg and Arinstein, 1921
butyric ac., lactic ac., succinic ac.	*B. subtilis* Vandewelde, 1884
citric ac.	*Citromyces, sp.*? Wehmer, 1913
citric ac.	*Citromyces citricus* Mazé and Perrier, 1904
citric ac., oxalic ac.	*Asp. niger* *Citromyces glaber* Butkewitsch, 1923
CO_2, glyceric ac., lactic ac.	*B. pyocyaneus* Supniewski, 1923
dihydroxyacetone	*Acetobacter suboxydans* Kluyver and deLeeuw, 1924
dihydroxyacetone	sorbose bacterium Bertrand, 1904
dihydroxyacetone	*B. dioxyacetonicum* Virtanen and Barlund, 1926
dihydroxyacetone	sorbose bacterium Bertrand, 1898
dihydroxyacetone	*B. xylinum* Virtanen and Barlund, 1926
dihydroxyacetone	*B. xylinum* Bernhauer and Schön, 1928
dihydroxyacetone	*Acetobacter suboxydans* *Bact. xylinum* Brit. patent 269, 950
dihydroxyacetone	*Bact. xylinum* Bertrand and Sazerac, 1901

Substrates Products	Microorganisms Authors
Glycerol (cont.)	
ethyl alc.	yeast Neuberg and Kerb, 1913
ethyl alc.	*Asp. niger* Kostytschew and Afanassjewa, 1922
ethyl alc., CO_2	yeast Kostytschew and Faermann, 1928
gluconic ac.	*Asp. niger* Bernhauer, 1928
oxalic ac.	*B. aceti*, *B. ascendens* *B. oxydans*, *B. Pasteurianum* *B. xylinum* *Termobacterium aceti* Banning, 1902
oxalic ac.	*Asp. niger* Elfving, 1919
oxymaltol	*Asp. glaucus* Traetta-Mosca and Preti, 1921
pyruvic ac.	*B. subtilis* Aubel, 1921
succinic ac.	*Rhizopus*, *sp.*? Takahashi and Sakaguchi, 1927
sucrose	yeast Connstein and Ludecke, 1919
Glycerose	
citric ac., oxalic ac.	*Asp. niger* Amelung, 1927
Glycolaldehyde	
ethylene glycol	yeast Neuberg and Schwenk, 1915
Glycollic ac.	
oxalic ac.	*B. aceti*, *B. acetigenum* *B. acetosum*, *B. ascendens* *B. Kützingianum*

Substrates Products	Microorganisms Authors
Glycollic ac. (cont.)	
	B. Pasteurianum *Termobacterium aceti* Banning, 1902
Glycuronic ac. acetic ac., CO_2, ethyl alc., formic ac., lactic ac., succinic ac.	*B. coli communis* Kay, 1926
Glyoxylic ac. acetaldehyde, CO_2	yeast Lebedev, 1918
Hydroxyfumaric ac. acetaldehyde, CO_2	yeast Mayer, 1913
Hydroxypyruvic ac. glycolaldehyde, CO_2,	yeast Neuberg and Kerb, 1913
Inositol acetaldehyde, CO_2, lactic ac., succinic ac.	*B. lactis aerogenes* Kumagawa, 1922
i-Inositol acetic ac., CO_2, ethyl alc., succinic ac.	*B. lactis* Hewitt and Steabbin, 1921
Inulin oxalic ac.	*Asp. niger* Elfving, 1919
Isobutyl alc. isobutyric ac.	*Acetobacter melanogenum* Visser't Hooft, 1925
Isobutyl aldehyde isobutyl alc.	yeast Ohta, 1914
Isobutyric ac. oxalic ac.	*B. aceti*, *B. Kützingianum* *B. Pasteurianum* Banning, 1902

Substrates Products	Microorganisms Authors
Isodulcite	
See rhamnose	
Isolichenin	
oxalic ac.	*B. aceti*, *B. industrium* *B. Kützingianum* Banning, 1902
Isopropyl alc.	
acetone	*Acetobacter melanogenum* *Acetobacter xylinum* visser't Hooft, 1925
α-Ketobutyric ac.	
ethyl alc., n-propyl alc.	yeast Neuberg and Kerb, 1914
propionaldehyde	yeast Neuberg and Kerb, 1912
propionaldehyde, propyl alc.	yeast Neuberg and Kerb, 1913
α-Keto-iso-valeric ac.	
isobutyl aldehyde	yeast Sen, 1923
α-Keto-n-caproic ac.	
n-amyl alc., n-valeraldehyde	yeast Sen, 1923
Lactic ac.	
acetaldehyde	*B. lactis aerogenes* Nagai, 1923
acetaldehyde, acetic ac., pyruvic ac.	*B. pyocyaneus* Supniewski, 1923
acetic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
acetic ac.	*Acetobacter melanogenum* *Acetobacter suboxydans* *Acetobacter xylinum* visser't Hooft, 1925
acetic ac., butyl alc., butyric ac.	*Amylobacter butylicus* Duclaux, 1895

Substrates Products	Microorganisms Authors
Lactic ac. (cont.)	
acetic ac., CO_2, propionic ac.	*Bact. acidi propionici* var. *fuscum* Virtanen, 1923
acetic ac., CO_2, propionic ac.	*B. acidi propionici* *Bact. acidi propionici-b* *Bact. acidi propionici-a* Von Freudenreich and Orla-Jensen, 1906
acetic ac., CO_2, propionic ac., succinic ac.	*Propionibacterium Freudenreichii* *Propionibacterium Jensenii* *Propionibacterium pentosaceum* *Propionibacterium Peterssonii* *Propionibacterium rubrum* *Propionibacterium Shermanii* *Propionibacterium technicum* *Propionibacterium Thönii* Van Niel, 1928
acetic ac., ethyl alc., formic ac.	*B. ethoacetosuccinicus* Mazé, 1913
acetic ac., ethyl alc., l-lactic ac., succinic ac.	*B. coli* Grimbert, 1896
acetic ac., propionic ac.	*B. motilis* Orla-Jensen, 1904
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetylmethyl carbinol	*B. subtilis* Lemoigne, 1923
2, 3-butylene glycol	*B. mesenterious-ruber* Lemoigne, 1913
butyl alc., butyric ac., caproic ac., caprylic ac.	*B. butylicus* Neuberg and Arinstein, 1921
citric ac.	*Asp. fumaricus* Schreyer, 1928
ethyl alc.	*Asp. niger* Kostytschew and Afanassjewa, 1922

Substrates Products	Microorganisms Authors
Lactic ac. (cont.)	
ethyl alc., pyruvic ac.	yeast Kayser, 1923
oxalic ac.	*B. Kützingianum* *Termobacterium aceti* Banning, 1902
propionic ac., valeric ac.	*B. subtilis* Fitz, 1880
pyruvic ac.	*Amylomyces Rouxii* Mazé and Ruot, 1916
pyruvic ac.	*B. coli communis* *B. pyocyaneus* Quastel, Stephenson and Whetham, 1925
Lactose	
acetaldehyde	*Bact. coli.*, *B. lactis aerogenes* Nagai, 1923
acetaldehyde	yeast Trillat, 1908
acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. tartricus* Grimbert, 1901
acetic ac., butyl alc., butyric ac., CO_2, ethyl alc., H_2, lactic ac.	*Amylobacter butylicus* Duclaux, 1895
acetic ac., propionic ac.	*Bact. acidi propionici d* Sherman and Shaw, 1923
acetic ac., propionic ac., succinic ac.	*Bact. acidi propionici* Virtanen, 1923
acetic ac., succinic ac.	*B. lactis aerogenes* Emmerling, 1900
citric ac.	*Citromyces, sp.?* Wehmer, 1913
lactic ac.	*Lactobacillus leichmani* Fred, Peterson and Stiles, 1925

Substrates Products	Microorganisms Authors
Lactose (cont.)	
lactic ac.	*B. coli* Péré, 1898
lactic ac., methylglyoxal, pyruvic ac.	*Bact. caucasicum* Kostytschew and Soldatenkov, 1927
oxalic ac.	*Asp. niger* Elfving, 1919
Levulose	
acetaldehyde	*Bact. coli, B. lactis aerogenes* Nagai, 1923
acetic ac., butyric ac., CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*Sarcina maxima* Smit, 1928
acetic ac., CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. coli communis* Harden, 1901
acetic ac., ethyl alc., formic ac., lactic ac.	*Bact. pyocyaneus* Aubel, 1921
acetic ac., lactic ac., mannitol	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Walpole, 1911
acetylmethyl carbinol, 2, 3-butylene glycol	*B. cloacae* Harden and Norris, 1912
acetylmethyl carbinol, 2, 3-butylene glycol	yeast Kluyver, Donker and Hooft, 1925
acetylmethyl carbinol 2,3-butylene glycol	yeast Kluyver and Donker, 1924
acetylmethyl carbinol	yeast Neuberg and Reinfurth, 1923
citric ac., oxalic ac.	*Asp. niger* Amelung, 1927

Substrates Products	Microorganisms Authors
Levulose (cont.)	
fumaric ac.	*Rhizopus nigricans* Ehrlich, 1912
gluconic ac.	*Asp. niger* Bernhauer, 1928
lactic ac.	*Lactobacillus leichmani* Fred, Peterson and Stiles, 1925
d-lactic ac.	*Clostridium thermocellum* Peterson, Fred and Martin, 1926
oxalic ac.	*B. aceti*, *B. oxydans*, *B. xylinum* Banning, 1902
Malic ac.	
acetaldehyde	*B. coli* Nagai, 1923
acetic ac., ethyl alc., succinic ac.	*B. coli communis* Grey, 1923
acetic ac., lactic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
acetic ac., succinic ac.	*B. lactis aerogenes* Emmerling, 1899
fumaric ac.	*B. coli communis* Quastel and Whetham, 1924
lactic ac.	yeast Lebedev and Russ, 1916
oxalic ac.	*Asp. niger* Raistrick and Clark, 1919
pyruvic ac.	*B. fluorescens* Bejerinck and Folpmers, 1916
Malonic ac.	
acetic ac., ethyl alc., lactic ac.	*B. coli communis* Grey, 1923
oxalic ac.	*B. aceti*, *B. acetosum* *B. ascendens*, *B. Kützingianum* *B. Pasteurianum*

Substrates Products	Microorganisms Authors
Malic ac. (cont.)	
	Termobacterium aceti Banning, 1902
Maltose	
acetaldehyde	*Bact. coli*, *B. lactis aerogenes* Nagai, 1923
acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. tartricus* Grimbert, 1901
acetic ac., butyl alc., butyric ac., CO_2, ethyl alc., H_2, lactic ac.	*Amylobacter butylicus* Duclaux, 1895
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetone, ethyl alc., pyruvic ac.	*B. acetoethylicum* Speakman, 1925
acetylmethyl carbinol	*B. anthracis* Lemoigne, 1919
citric ac., oxalic ac.	*Asp. niger* Amelung, 1927
Mannitol	
acetic ac., CO_2, ethyl alc., formic ac., lactic ac., succinic ac.	*B. cloacae*, *B. coli*, *B. lactis aerogenes* Thompson, 1912
acetic ac., acetone, butyl alc., butyric ac., lactic ac.	*B. granulobacter pectinovorum* Speakman, 1923
acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. tartricus* Grimbert, 1901
acetic ac., acetylmethyl carbinol, ethyl alc., CO_2, formic ac., lactic ac., succinic ac.	*B. lactis aerogenes* Kay, 1926
acetic ac., butyl alc., butyric ac., CO_2, ethyl alc., H_2, lactic ac.	*Amylobacter butylicus* Duclaux, 1895

Substrates Products	Microorganisms Authors
Mannitol (cont.)	
acetic ac., CO_2, ethyl alc., H_2	*B. ethaceticus* Frankland and Lumsden, 1892
acetic ac., CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. coli communis* Grey, 1918
acetic ac., CO_2, ethyl alc., H_2, lactic ac., succinic ac.	*B. coli communis* Harden, 1901
acetic ac., CO_2, ethyl alc., H_2, succinic ac.	*B. ethacetosuccinicus* Frankland and Frew, 1892
acetic ac., ethyl alc.	*B. ethaceticus* Frankland, Stanley and Frew, 1891
acetic ac., ethyl alc.	Friedlander's pneumococcus Frankland, Stanley and Frew, 1891
acetic ac., CO_2, ethyl alc., formic ac., lactic ac., succinic ac.,	*B. coli communis* Kay, 1926
acetic ac., ethyl alc., formic ac., succinic ac.	*B. ethaceticus* Frankland and Fox, 1889
acetic ac., ethyl alc., l-lactic ac.	Friedlander's pneumobacillus Grimbert, 1896
acetic ac., lactic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
acetylmethyl carbinol	*B. subtilis* *Tyrothrix tenuis* *B. mesentericus vulgatus* Harden and Norris, 1912
acetylmethyl carbinol, 2, 3-butylene glycol	*B. cloacae* Thompson, 1912
acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Harden and Norris, 1912
butyl alc.	*B. butylicus* Emmerling, 1897
butyl alc., butyric ac., lactic ac.	*B. butylicus* Fitz, 1882

Substrates Products	Microorganisms Authors
Mannitol (cont.)	
citric ac.	*Asp. fumaricus* Schreyer, 1928
citric ac., oxalic ac.	*Asp. niger*, *Citromyces glaber* Butkewitsch, 1923
ethyl alc.	*Asp. niger* Kostytschew and Afanassjewa, 1922
ethyl alc., CO_2	yeast Kostytschew and Faermann, 1928
lactic ac.	*B. coli* Péré, 1898
levulose	*Acetobacter suboxydans* Kluyver and deLeeuw, 1924
levulose	*Bact. aceti* Brown, 1886
levulose	*B. xylinum* Hoyer, 1898
levulose	Sorbose bacterium Bertrand, 1898
oxalic ac.	*Asp. niger* Elfving, 1919
oxalic ac.	*B. industrium* Banning, 1902
Mannose	
acetic ac., ethyl alc., lactic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetylmethyl carbinol, 2, 3-butylene glycol	*B. cloacae* Harden and Norris, 1912
acetylmethyl carbinol, 2, 3-butylene glycol	*B. lactis aerogenes* Harden and Norris, 1912
citric ac.	*Citromyces, sp.?* Wehmer, 1913

Substrates Products	Microorganisms Authors
Mannose (cont.)	
ethyl alc.	yeast Mezzadroli, 1918
gluconic ac.	*Asp. niger* Bernhauer, 1928
lactic ac.	*B. coli* Péré, 1898
p-Methoxy-benzaldehyde	
p-methoxy-benzoic ac., p-methoxy-benzyl alc.	yeast Neuberg and Liebermann, 1921
Methyl acetol	
See acetylmethyl carbinol	
Methyl alc.	
formic ac.	*B. pyocyaneus* Supniewski, 1923
Methyl-benzoyl carbinol+dextrose	
methyl-phenylethylene glycol	yeast Neuberg and Komarewsky, 1927
Methyl-α-chloroethyl ketone	
methyl-α-chloroethyl alc.	yeast Santomauro, 1924
o-methyl-cyclohexanone	
o-methyl cyclohexanol	yeast Akamatsu, 1923
d-l-methylethyl-acetaldehyde	
d-amyl alc., valeric ac.	*B. pasteurianum* Neuberg and Simon, 1926
Methylethylacetaldehyde	
i-amyl alc., i-valeric ac.	*B. ascendens* *B. xylinum* Neuberg and Simon, 1926
Methylethylketone+sucrose	
d-methylethyl carbinol	yeast Neuberg and Nord, 1919

Substrates Products	Microorganisms Authors
Methyl-ethyl pyruvic ac.	
methyl-ethyl acetaldehyde	yeast Neuberg and Peterson, 1914
Methylglyoxal	
lactic ac.	*Bact. coli*, *Bact. pasteurianum* Gorr and Perlmann, 1926
lactic ac.	*B. coli*, *B. propionicus*, *Lactobacillus, sp.*? Neuberg and Gorr, 1926
lactic ac., mandelic ac.	yeast Dakin and Dudley, 1913
d-lactic ac.	yeast Neuberg and Kobel, 1927, 1929
d-l-lactic ac.	yeast Neuberg, 1913
d-l-lactic ac.	*B. Delbrücki* Neuberg and Simon, 1927
Methylglyoxal + sucrose	
l-propylene glycol	yeast Neuberg and Kobel, 1927
Methyl-n-hexyl ketone + sucrose	
d-methyl hexyl carbinol	yeast Neuberg and Nord, 1919
Methyl nonyl ketone + sucrose	
d-methyl nonyl carbinol	yeast Neuberg and Nord, 1919
Methyl-n-propyl ketone + sucrose	
d-methyl-n-propyl carbinol	yeast Neuberg and Nord, 1919
Oleic ac.	
keto-stearic ac.	*Pen. glaucum* Pigulewski and Charik, 1928

Substrates Products	Microorganisms Authors
Propionic ac.	
butyl alc., butyric ac., caproic ac., caprylic alc.	*B. butylicus* Neuberg and Arinstein, 1921
Propyl alc.	
propionic ac.	*Bact. aceti* Brown, 1886
propionic ac.	*B. Kützingianum* *B. Pasteurianum* Mayer, 1898
propionic ac.	*Acetobacter, sp.?* *B. aceti* (Hansen) Buchner and Gaunt, 1906
Propylene Glycol	
acetic ac., CO_2, propionic ac., succinic ac.	*Propionibacterium Jensenii* *Propionibacterium technicum* Van Niel, 1928
acetic ac., CO_2, formic ac., glycollic ac., H_2, i-lactic ac., propionic ac.	*B. coli* Aubel, 1924
acetic ac., fumaric ac., lactic ac.	*Rhizopus nigricans* Gottschalk, 1925
acetyl carbinol	*Mycoderma aceti* Kling, 1905
acetylmethyl carbinol	yeast Neuberg and May, 1923
acetylmethyl carbinol	yeast Hirsch, 1922
aldol	yeast Neuberg, 1912
ethyl alc.	yeast Neuberg and Kerb, 1913
lactic ac.	*B. pyocyaneus* Aubel, 1924
α-propylene glycol	
acetyl carbinol	*Acetobacter xylinum* visser't Hooft, 1925

Substrates Products	Microorganisms Authors
Quinic ac. (cont.)	
protocatechuic ac.	*Micrococcus chinicus* Emmerling and Abderhalden, 1903
protocatechuic ac.	*Asp. niger*, *Asp. oryzae* *Citromyces glaber* Butkewitsch, 1924
Rhamnose	
acetylmethyl carbinol, 2, 3-butylene glycol	*B. cloacae* *B. lactis aerogenes* Harden and Norris, 1912
Raffinose	
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe, and Morgan, 1919
arabin	*B. spongiosus* Ruhland, 1906
oxalic ac.	*Asp. niger* Gillot, 1899
oxalic ac.	*B. aceti*, *B. ascendens* *B. xylinum* Banning, 1902
Saccharic ac.	
acetic ac., ethyl alc., formic ac., lactic ac., succinic ac.	*B. coli communis* Kay, 1926
acetic ac., acetylmethyl carbinol, CO_2, ethyl alc., formic ac., lactic ac., succinic ac.	*B. lactis aerogenes* Kay, 1926
citric ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
oxalic ac.	*Asp. niger* Butkewitsch, 1923
Sorbitol	
sorbose	*Acet. suboxydans* Kluyver and deLeeuw, 1924

Substrates Products	Microorganisms Authors
Sorbitol (cont.)	
sorbose	sorbose bacterium Bertrand, 1898
sorbose	*B. xylinum* Seifert, 1897, Mayer, 1898, Noyer, 1898
Starch	
acetaldehyde	*B. acetoethylicum* Peterson and Fred, 1920
acetaldehyde, acetic ac., butyric ac., ethyl alc., formic ac.	*B. suaveolens* Sclavo and Gosio, 1891
acetic ac., acetone, butyl alc., butyric ac.	*B. granulobacter pectinovorum* Speakman, 1923
acetic ac., acetone, ethyl alc., formic ac., lactic ac.	*B. acetoethylicum* Arzberger, Peterson and Fred, 1920
acetic ac., butyl alc., butyric ac., CO_2, ethyl alc., H_2, lactic ac.	*Amylobacter butylicus* Duclaux, 1895
acetic ac., butyl alc., formic ac., lactic ac., succinic ac.	*Pectinobacter amylophilum* Makrinov, 1915
acetic ac., butyric ac., ethyl alc., succinic ac.	*B. subtilis* Fitz, 1878
acetic ac., CO_2, propionic ac., succinic ac.	*Propionibacterium technicum* Van Niel, 1928
acetone, butyl alc., CO_2, ethyl alc., H_2	*Cl. acetobutylicum* Killeffer, 1927
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetone, ethyl alc., fusel oil	*B. acetoethylicus* Bakonyi, 1926
amylobiose, dihexosan	*Saccharomyces Saké* Sjöberg, 1927
dextrin	*B. amylobacter* Villiers, 1891

Substrates Products	Microorganisms Authors
Starch (cont.)	
dextrose	*B. anthracis* Maumus, 1893
ethyl alc.	*Mucor circinelloides* (?) Gayon and Dubourg, 1886
ethyl alc., isobutyl alc., isopropyl alc., n-butyl alc., propyl alc.	*Granulobacterium butylicum* Folpmers, 1921
maltose	*Bact. thermoamylolyticus* Coolhaas, 1928
oxalic ac.	*Asp. niger* Wehmer, 1891
Succinic ac.	
acetic ac.	*Micrococcus casei liquefaciens* Orla-Jensen, 1904
acetic ac., formic ac., H_2	*B. coli communis* Grey, 1923
acetic ac., propionic ac.	*B. casei* Orla-Jensen, 1904
fumaric ac.	*B. coli communis* Quastel and Whetham, 1924
oxalic ac.	*Asp. niger* Raistrick and Clark, 1919
propionic ac.	*B. pyocyaneus* Quastel, 1924
Sucrose	
acetaldehyde	yeast Paris, 1922
acetaldehyde	*B. coli*, *B. lactis aerogenes* Nagai, 1923
acetaldehyde, acetic ac., CO_2, ethyl alc., glycerol	*Sacc. Saké*, *Zygosacc. major*, *Zygosacc. salsus* Kumagawa, 1922
acetaldehyde, acetic ac., ethyl alc., glycerol	yeast Neuberg and Hirsch, 1919
acetaldehyde, ethyl alc.	yeast Gehle, 1922

Substrates Products	Microorganisms Authors
Sucrose (cont.)	
acetaldehyde, ethyl alc.	yeast Zerner, 1920
acetaldehyde, glycerol	yeast Neuberg and Reinfurth, 1918
acetaldehyde, acetic ac., ethyl alc., lactic ac.	*Amylobacter ethylicus* Duclaux, 1895
acetic ac.	*Diplococcus pneumoniae* Brieger, 1883
acetic ac., acetone, ethyl alc. lactic ac.	*B. invertenti-acetici* Mezzadroli, 1917
acetic ac., acetylmethylcarbinol, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
acetic ac., butyl alc., butyric ac., CO_2, ethyl alc., H_2, lactic ac.	*Amylobacter butylicus* Duclaux, 1895
acetic ac., lactic ac.	*B. invertenti-lattici* Mezzadroli, 1917
acetic ac., malic ac., succinic ac.	yeast Kostytschew and Frey, 1925
acetone, ethyl alc., fusel oil	*B. acetoethylicus* Bakonyi, 1926
acetone, ethyl alc., fusel oil	*B. macerans* Bakonyi, 1926
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
acetylmethyl carbinol	*B. anthracis* Lemoigne, 1919
acetylmethyl carbinol	*B. subtilis* Lemoigne, 1913
acetylmethyl carbinol	yeast Neuberg and Simon, 1925
acetylmethyl carbinol, 2, 3-butylene glycol	*B. subtilis* Lemoigne, 1912

Substrates Products	Microorganisms Authors
Sucrose (cont.)	
arabin	*B. spongiosus* Ruhland, 1906
butyl alc., butyric ac., lactic ac.	*B. butylicus* Fitz, 1882
2, 3-butylene glycol	yeast Henninger, 1888
citric ac.	*Asp. niger* Bernhauer, 1928
citric ac.	*Citromyces*, sp.? Wehmer, 1913
citric ac.	*Citromyces*, sp.? Filosofov and Malinovskii, 1928
citric ac.	*Citromyces* (Wehmer) Mazé, 1909
citric ac., fumaric ac., gluconic ac., malic ac.	*Asp. fumaricus* Wehmer, 1918, 1928
citric ac., gluconic ac.	*Citromyces glaber* *Pen. glaucum* Butkewitsch, 1927
citric ac., gluconic ac., oxalic ac.	*Asp. niger* Bernhauer, 1924, 1926
citric ac., gluconic ac., oxalic ac.	*Asp. niger* Butkewitsch, 1924
citric ac., gluconic ac., oxalic ac.	*Sterigmatocystis nigra* Molliard, 1922
citric ac., oxalic ac.	*Asp. niger* Currie, 1917
citric ac., oxalic ac.	*Asp. niger* Amelung, 1927
citric ac., oxalic ac.	*Asp. niger* *Citromyces glaber* Butkewitsch, 1923
ethyl alc.	*Mucor racemosus* Fitz, 1876

Substrates Products	Microorganisms Authors
Sucrose (cont.)	
ethyl alc.	*Asp. niger* Kostytschew and Afanassjewa, 1922
ethyl alc.	*Mucor mucedo* *Mucor racemosus* *Mucor stolonifer* Kostytschew and Eliasberg, 1920
ethyl alc.	*Pen. glaucum* Kostytschew and Afanassjewa, 1922
ethyl alc., glycerol, succinic ac.	*Mucor racemosus* Emmerling, 1897
ethyl alc., succinic ac.	*Mucor mucedo* Fitz, 1873
gluconic ac.	*Asp. niger* Bernhauer, 1928
glycerol	*Sacc. ellipsoideus* Adams, 1919
glycerol	yeast Buchner and Meisenheimer, 1906
glycerol	yeast Connstein and Ludecke, 1919
glycerol	yeast Abderhalden and Stix, 1922
glycerol	yeast Tomoda, 1928
gum levan	*B. vulgatus* Owen, 1923
lactic ac.	*B. coli* Péré, 1898
lactic ac.	yeast Fernbach and Schoen, 1923
l-lactic ac.	*B. acidi laevolactici* Schardinger, 1890

Substrates Products	Microorganisms Authors
Sucrose (cont.)	
l-lactic ac.	*B. casei E.* Virtanen, Wichmann and Lindström, 1927
d-lactic ac.	*Strep. lactis* Virtanen, Wichmann and Lindström, 1927
lactic ac., methylglyoxal	*B. coli* Virtanen and Simola, 1927
l-malic ac.	yeast Dakin, 1924
oxalic ac.	*Asp. niger* Elfving, 1919
oxalic ac.	*B. aceti* *B. Pasteurianum* Banning, 1902
oxalic ac., citric ac.	*Citromyces citricus* *Citromyces glaber* *Citromyces Pfefferianus* *Penicillium glaucum* Butkewitsch, 1922
pyruvic ac.	yeast Klein and Fuchs, 1929
Sucrose+Methyl Glyoxal	
l-propylene glycol	yeast Neuberg and Kobel, 1927
pyruvic ac.	yeast Fernbach and Schoen, 1913
Tartaric ac.	
acetaldehyde	*B. coli* *B. lactis aerogenes* Nagai, 1923
acetic ac., ethyl alc., succinic ac.	*B. coli communis* Grey, 1923
acetic ac., propionic ac., succinic ac.	*Bact. termo* König, 1881

Substrates Products	Microorganisms Authors
Tartaric ac. (cont.)	
butyric ac., lactic ac., propionic ac., succinic ac.	yeast Karczag, 1912
ethyl alc.	*Asp. niger* Kostytschew and Afanassjewa, 1912
oxalic ac.	*Asp. niger* Wehmer, 1891
oxalic ac.	*Asp. niger* Raistrick and Clark, 1919
Thioacetaldehyde	
ethylmercaptan	yeast Neuberg and Nord, 1914
o-Tolyl Aldehyde	
o-tolyl-acetyl carbinol	yeast Behrens and Ivanoff, 1926
p-Tolyl Aldehyde	
p-tolyl-acetyl carbinol	yeast Behrens and Ivanoff, 1926
Trichlor Acetaldehyde	
trichlorethylalcohol	yeast Lintner and Lüers, 1913
α, α, β, Trichlorbutyl Aldehyde	
2, 2, 3-trichlorbutanol	yeast Rosenfeld, 1925
Valemite	
keto-hexose	sorbose bacterium Bertrand, 1898
n-Valeraldehyde	
n-amyl alc.	yeast Neuberg and Nord, 1914
Valeraldehyde	
amyl alc.	yeast Neuberg and Steenbock, 1914

Substrates Products	Microorganisms Authors
Xylan	
pentose (xylose?)	Actinomyces sp.? Patrick, Werkman and Hixon, 1930
p-xyloquinone	
p-xylohydroquinone	coli bacteria Neuberg and Simon, 1927
Xylose	
acetic ac., acetone, butyl alc., butyric ac., lactic ac.	*B. granulobacter pectinovorum* Speakman, 1923
acetic ac., acetylmethyl carbinol, 2, 3-butylene glycol, CO_2, ethyl alc., formic ac., H_2, lactic ac., succinic ac.	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
acetic ac., butyric ac., ethyl alc. formic ac., lactic ac., succinic ac.	*B. lactis aerogenes* *B. para typhoid* *B typhosus* Fred and Peterson, 1920
acetic ac., ethyl alc., l-lactic ac., succinic ac.	Friedlander's pneumobacillus Grimbert, 1896
acetic ac., CO_2, propionic ac.	*Propionibacterium pentosaceum* Werkman, Hixon, Fulmer and Rayburn, 1929
acetic ac., lactic ac.	*Lactobacillus pentosus* *Lactobacillus pentoaceticus* Fred, Peterson and Anderson, 1921
acetic ac., lactic ac.	*Lactobacillus pentoaceticus* Fred, Peterson and Davenport, 1919
acetone, butyl alc., CO_2	*B. granulobacter pectinovorum* Peterson, Fred and Schmidt, 1924

Substrates Products	Microorganisms Authors
Xylose (cont.)	
acetone, CO_2, ethyl alc.	*Acetobacter xylinum*, *B. herbicola aureum*, *B. vulgatus* Fred, Peterson and Anderson, 1923
acetone, ethyl alc., formic ac.	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
citric ac.	*Citromyces*, sp.? Wehmer, 1913
citric ac., oxalic ac.	*Asp. niger* Amelung, 1927
CO_2, ethyl alc., glyceric aldehyde (?)	*Sacc. cerevisiae* Abbott, 1926
xylonic ac.	sorbose bacterium Bertrand, 1898

TABLE III

INDEX TO PRODUCTS

TABLE THREE

INDEX TO PRODUCTS

Products Substrates	Microorganisms Authors
Acetaldehyde	
dextrose	*Asp. cellulosae* *Monilia candida* *Mucor racemosus* *Mucor rouxii* *Oidium lactis* Cohen, 1920
dextrose	*B. coli communis* Grey, 1913
dextrose	*B. dysenteriae*, Shiga-Kruse Bergh, 1928
dextrose	yeast Kostytschew, 1912
dextrose	*Oidium lupuli* Sumiki, 1927
dextrose	*B. lactis aerogenes* Neuberg, Nord and Wolff, 1920
dextrose	*Rhizopus*, sp.? Nill, 1927
dextrose, glycerol, inositol	*B. lactis aerogenes* Kumagawa, 1922
ethyl alc.	yeast Trillat and Sauton, 1908
ethyl alc.	*B. pyocyaneus* Supniewski, 1923
galactose	yeast Tomita, 1921
galactose, gluconic ac., glyceric ac., lactic ac., lactose, levulose, malic ac., maltose, sucrose, tartaric ac.	*B. coli* *B. lactis aerogenes* Nagai, 1923

Products Substrates	Microorganisms Authors
Acetaldehyde (cont.)	
glyceric ac.	yeast Lebedev, 1918
glyceric ac., pyruvic ac.	yeast Lebedev and Polonski, 1916
glyoxylic ac.	yeast Lebedev, 1918
hydroxyfumaric ac.	yeast Mayer, 1913
lactic ac.	*B. pyocyaneus* Supniewski, 1923
lactose	yeast Trillat, 1908
oxalacetic ac.	yeast Neuberg and Kerb, 1913
oxalacetic ac.	yeast Neuberg and Gorr, 1925
pyruvic ac.	yeast Neuberg and Kerb, 1912
pyruvic ac.	*Monilia candida*, *Oidium lactis* *Asp. niger mutante*, *Mucor rouxii* *Mucor racemosus* Nagayama, 1921
pyruvic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
pyruvic ac.	yeast Neuberg and Reinfürth, 1920
pyruvic ac.	yeast Gottschalk, 1923
pyruvic ac.	yeast Paris, 1922
starch	*B. acetoethylicum* Peterson and Fred, 1920
sucrose	*Sacc. Saké* *Zygosaccharomyces major* *Zygosaccharomyces salsus* Kumagawa, 1922

Products Substrates	Microorganisms Authors
Acetaldehyde (cont.)	
sucrose	*Amylobacter ethylicus* Duclaux, 1895
sucrose	yeast Gehle, 1922
sucrose	yeast Neuberg and Reinfürth, 1918
sucrose	yeast Zerner, 1920
Acetic ac.	
acetaldehyde	yeast Kostytschew, 1914
acetaldehyde	*B. lactis aerogenes* Harden and Norris, 1912
acetaldehyde	*B. pyocyaneus* Supniewski, 1923
acetone	*B. pyocyaneus* Supniewski, 1923
arabinose	*B. ethaceticum* Frankland and MacGregor, 1892
arabinose	*Lactobacillus arabinosus* Fred, Peterson and Anderson, 1921
arabinose	Pneumobacillus of Friedlander Grimbert, 1896
arabinose, dextrose, galactose, levulose, mannitol	*B. coli communis* Harden, 1901
arabinose, dextrose, galactose, mannitol, starch, xylose	*B. granulobacter pectinovorum* Speakman, 1923
arabinose, xylose	*Lactob. pentosus* *Lactob. pentoaceticus* Fred, Peterson and Anderson, 1921
arabinose, dextrose, glycerol, lactic ac., starch, xylose	*Propionibacterium pentosaceum* Werkman, Hixon, Fulmer and Rayburn, 1929

Products Substrates	Microorganisms Authors
Acetic ac. (cont.)	
cellulose	*Clostridium thermocellum* Viljoen, Fred and Peterson, 1926
cellulose	*B. cellulosae dissolvens* Khouvine, 1923
cellulose	*Bact. cellaresolvens* *Bact. opalescens* Groenewege, 1923
citric ac.	*B. coli communis* Grey, 1923
citric ac.	*B. suipestifer* Brown, Duncan and Henry, 1924
dextrose	*B. coli communis* Grey and Young, 1921
dextrose	*Granulobacter saccharobutyricum* Donker, 1926
dextrose	*B. aerogenes* *B. coli* Virtanen and Simola, 1927
dextrose	*Clostridium pasteurianum* Donker, 1926
dextrose	*B. coli communis* Young, 1924
dextrose	*B. acetoethylicum* Donker, 1926
dextrose	*B. polymyxa* Donker, 1926
dextrose	*Asp. niger* Heinze, 1903
dextrose	*B. granulobacter pectinovorum*, Weizmann Donker, 1926
dextrose	*B. butylicus* Buchner and Meisenheimer, 1908

Products Substrates	Microorganisms Authors
Acetic ac. (cont.)	
dextrose	*B. dysenteriae*, Shiga-Kruse Bergh, 1929
dextrose	*B. coli communis* Grey, 1918
dextrose	*B. typhosus* Harden, 1901
dextrose	*B. typhosum* Scheffer, 1928
dextrose	*B. coli* Scheffer, 1928
dextrose	*B. dysenteriae*, Shiga-Kruse Scheffer, 1928
dextrose	*B. aerogenes* Scheffer, 1928
dextrose	*B. coli communis* Harden, 1899
dextrose	*Oidium lupuli* Sumiki, 1927
dextrose	*B. coli* Grimbert, 1896
dextrose	*Cl. Pasteurianum* Winogradsky, 1902
dextrose	Friedlander's pneumococcus Frankland, Stanley and Frew, 1891
dextrose	*Serratia marcescens* Pederson and Breed, 1928
dextrose, galactose, lactic ac., mannose	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
dextrose, gluconic ac., mannitol, saccharic ac.	*B. lactis aerogenes* Kay, 1926
dextrose, glycerol, lactic ac.	*Propionibacterium Freudenreichii* *Propionibacterium Peterssonii* *Propionibacterium Shermanii* *Propionibacterium Thönii* van Niel, 1928

Products Substrates	Microorganisms Authors
Acetic ac (cont.)	
dextrose, glycerol, lactic ac., pyruvic ac.	*Propionibacterium Jensenii* van Niel, 1928
dextrose, glycerol, lactic ac., pyruvic ac., starch	*Propionibacterium technicum* van Niel, 1928
dextrose, glycerol, lactic ac.	*Propionibacterium pentosaceum* van Niel, 1928
dextrose, lactic ac.	*Propionibacterium rubrum* van Niel, 1928
dextrose, lactose, maltose, mannitol, sucrose	*B. tartricus* Grimbert, 1901
dextrose, lactic ac., lactose, pyruvic ac.	*Bact. acidi propionici*, var. *fuscum* Virtanen, 1923
dextrose, levulose	*Bact. pyocyaneus* Aubel, 1921
dextrose, mannitol	*B. coli communis* Grey, 1918
dextrose, mannitol	*B. ethaceticus* Frankland and Lumsden, 1892
dextrose, mannitol	*B. cloacae* *B. coli* *B. lactis aerogenes* Thompson, 1912
dextrose, mannitol	*B. lactis aerogenes* Harden and Walpole, 1906
dextrose, gluconic ac., glycuronic ac., mannitol, saccharic ac.	*B. coli communis* Kay, 1926
dextrose, starch, sucrose	*B. acetoethylicum* Arzberger, Peterson and Fred, 1920
dulcitol	Pneumobacillus of Friedländer Grimbert, 1896
dulcitol, mannitol	*B. ethacetosuccinicus* Frankland and Frew, 1892
ethyl alc.	*Bact. aceti* Brown, 1886

Products Substrates	Microorganisms Authors
Acetic ac. (cont.)	
ethyl alc.	*Acetobacter*, sp.? Knieriem and Mayer, 1872 Buchner and Gaunt, 1906 Day and Baker, 1913 Söhngen, 1913
ethyl alc.	*Acetobacter suboxydans* visser't Hooft, 1925
ethyl alc.	*Bact. aceti viscosum* Day and Baker, 1913
ethyl alc.	*B. aceti* (Hansen) Buchner and Gaunt, 1913
ethyl alc.	*B. Kützingianum* Mayer, 1898
ethyl alc.	*B. Pasteurianum* Mayer, 1898
ethyl alc.	*B. pyocyaneus* Supniewski, 1923
fumaric ac.	*B. pyocyaneus* Quastel, 1924
glyceric ac.	yeast Lebedev, 1918
glycerol	*B. coli communis* Grey, 1923
glycerol	*Bact. aerogenes* *Bact. coli* *Bact. Freundii* Braak, 1928
glycerol	*B. lactis aerogenes* Harden and Norris, 1912
glycerol, lactic ac.	*Amylobacter butylicus* Duclaux, 1895
i-inositol	*B. lactis* Hewitt and Steabben, 1921
lactic ac.	*Acetobacter melanogenum* *Acetobacter suboxydans*

Products Substrates	Microorganisms Authors
Acetic ac. (cont.)	
	Acetobacter xylinum Visser't Hooft, 1925
lactic ac.	*B. pyocyaneus* Supniewski, 1923
lactic ac.	*B. acidi propionici* *B. acidi propionici-b* *B. acidi propionici-a* von Freudenreich and Jensen, 1906
lactic ac.	*B. ethacetosuccinicus* Mazé, 1913
lactic ac.	*B. casei* *B. mobilis* *Micrococcus casei liquefaciens* Orla-Jensen, 1904
lactose	*Bact. acidi propionici* Sherman and Shaw, 1923
lactose	*B lactis aerogenes* Emmerling, 1900
lactose	*B. coli* Grimbert, 1896
lactose, maltose, mannitol, starch, sucrose	*Amylobacter butylicus* Duclaux, 1895
levulose	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
malic ac.	*B. coli communis* Grey, 1923
malic ac.	*B. lactis aerogenes* Emmerling, 1899
malic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
malonic ac.	*B. coli communis* Grey, 1923
mannitol	Pneumobacillus of Friedlander Grimbert, 1896

Products Substrates	Microorganisms Authors
Acetic ac. (cont.)	
mannitol	Friedlander's pneumococcus Frankland, Stanley and Frew, 1891
mannitol	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
mannitol	*B. ethaceticus* Frankland, Stanley and Frew, 1891
mannitol, glycerol	*B. ethaceticus* Frankland and Fox, 1889
pyruvic ac.	*Bact. coli* Aubel, 1924
pyruvic ac.	*B. coli*, *B. proteus vulgatus* *B. pyocyaneus* Cambier and Aubel, 1922
pyruvic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
pyruvic ac.	*Rhizopus nigricans* Gottschalk, 1925
pyruvic ac.	yeast Lebedev and Polonski, 1917
quinic ac.	Schizomycetes Loew, 1881
starch	*B. suaveolens* Sclavo and Gosio, 1891
starch	*B. subtilis* Fitz, 1878
starch	*Pectinobacter amylophilum* Makrinov, 1915
succinic ac.	*B. coli communis* Grey, 1923
succinic ac.	*B. casei* *Micrococcus casei liquefaciens* Orla-Jensen, 1904

Products Substrates	Microorganisms Authors
Acetic ac. (cont.)	
sucrose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
sucrose	*B. invertenti-lattici* *B. invertenti-acetici* Mezzadroli, 1917
sucrose	*Diplococcus pneumoniae* Brieger, 1883
sucrose	*Amylobacter ethylicus* Duclaux, 1895
sucrose	*Sacc. Saké*, *Zygosacc. major*, *Zygosacc. salsus* Kumagawa, 1922
sucrose	yeast Kostytschew and Frey, 1925
tartaric ac.	*B. coli communis* Grey, 1923
tartaric ac.	*B. tartricus* Grimbert and Ficquet, 1898
tartaric ac.	*Bact. termo* König, 1881
xylose	Pneumobacillus of Friedländer Grimbert, 1896
xylose	*Lactobacillus pentoaceticus* Fred, Peterson and Davenport, 1919
xylose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
xylose	*B. lactis aerogenes*, *B. paratyphoid* *B. typhosus* Fred and Peterson, 1920
Acetoacetic ac.	
butyric ac.	*Asp. niger* Coppock, Subramaniam and Walker, 1928

Products Substrates	Microorganisms Authors
Acetoin	
See acetylmethyl carbinol	
Acetol	
See acetyl carbinol	
Acetone	
arabinose, dextrin, dextrose, galactose, glycerol, lactic ac., levulose, maltose, mannose, raffinose, starch, sucrose, xylose	*B. acetoethylicum* Northrop, Ashe and Morgan 1919
arabinose, dextrose, galactose, mannitol, starch, xylose	*B. granulobacter pectinovorum* Speakman, 1923
arabinose, xylose	*B. granulobacter pectinovorum* Peterson, Fred and Schmidt, 1924
butyric ac.	*Asp. niger* Coppock, Subramaniam and Walker, 1928
2, 3-butylene glycol	*Acetobacter suboxydans* *Acetobacter xylinum* visser't Hooft, 1925
citric ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
dextrose	*Cl. pasteurianum* Donker, 1926
dextrose	*B. granulobacter pectinovorum* Donker, 1926
dextrose	*B. acetoethylicum* Donker, 1926
dextrose	*B. polymyxa* Donker, 1926
dextrose, maltose	*B. acetoethylicum* Speakman, 1925

Products Substrates	Microorganisms Authors
Acetone (cont.)	
dextrose, starch, sucrose	*B. acetoethylicum* Arzberger, Peterson and Fred, 1920
isopropyl alc.	*Acetobacter xylinum* visser't Hooft, 1925
oxalacetic ac.	yeast Neuberg and Gorr, 1925
starch	*Cl. acetobutylicum* Killeffer, 1927
starch, sucrose	*B. acetoethylicus* *B. macerans* Bakonyi, 1926
sucrose	*B. invertenti-acetici* Mezzadroli, 1917
xylose	*Acetobacter xylinum*, *B. vulgatus* Fred, Peterson and Anderson, 1923
Acetone dicarboxylic ac.	
citric ac.	*Asp. niger* Walker, Subramaniam and Challenger, 1927
Acetyl carbinol	
d-l-propylene glycol	*Mycoderma aceti* Kling, 1901, 1905
Acetyl chlorbenzyl carbinol	
chlorobenzaldehyde	yeast Neuberg and Liebermann, 1921
Acetylmethyl carbinol	
acetaldehyde, sucrose	yeast Neuberg and Simon, 1925
adonitol, mannitol	*B. lactis aerogenes* Harden and Norris, 1912
arabinose, dextrose, galactose, isodulcite, mannose	*B. cloacae* *B. lactis aerogenes* Harden and Norris, 1912

Products Substrates	Microorganisms Authors
Acetylmethyl carbinol (cont.)	
2, 3-butylene glycol	*Mycoderma aceti* Kling, 1905
dextrose	*B. lactis aerogenes* Neuberg, Nord and Wolff, 1920
dextrose	*Serratia marcescens* Pederson and Breed, 1928
dextrose	*B. granulobacter pectinovorum*, Weizmann Donker, 1926
dextrose	*B. acetoethylicum* Donker, 1926
dextrose	*B. polymyxa* Donker, 1926
dextrose	*B. aerogenes* *B. cloacae* Scheffer, 1928
dextrose, lactic ac.	*B. proteus*, *B. subtilis* Lemoigne, 1923
dextrose, lactose, maltose, mannitol, sucrose	*B. tartricus* Grimbert, 1901
dextrose, levulose	*B. lactis aerogenes* Walpole, 1911
dextrose, levulose	*Sarcina ventriculi* Smit, 1928
dextrose, levulose	yeast Kluyver, Donker and Hooft 1925
dextrose, levulose, sucrose, acetaldehyde	yeast Neuberg and Reinfürth, 1923
dextrose, mannitol	*B. cloacae* Thompson, 1912
dextrose, mannitol	*B. lactis aerogenes* Harden and Walpole, 1906
dextrose, mannitol	*B. mesentericus vulgatus* *B. subtilis*

Products Substrates	Microorganisms Authors
Acetylmethyl carbinol (cont.)	
	Tyrothrix tenuis Harden and Norris, 1912
dextrose, gluconic ac., mannitol, saccharic ac.	*B. lactis aerogenes* Kay, 1926
glycerol	*Tyrothrix tenuis* Harden and Norris, 1912
levulose	yeast Kluyver and Donker, 1924
maltose, sucrose	*B. anthracis* Lemoigne, 1919
mannitol	*B. mesentericus vulgatus* Harden and Norris, 1912
oxalacetic ac.	yeast Neuberg and Gorr, 1924
pyruvic ac.	yeast Hirsch, 1922
sucrose	*B. subtilis* Lemoigne, 1913
sucrose, xylose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
Acrolein	
glycerol	*B. Welchii* Humphreys, 1924
glycerol	*B. amaracrylus* Voisenet, 1918
Acrylaldehyde See acrolein	
Adoninulose	
adonitol	*Acetobacter suboxydans* Visser't Hooft, 1925
Aldol	
pyruvic ac.	yeast Neuberg, 1912

Products Substrates	Microorganisms Authors
d-Amyl alc.	
d-l-methylethyl acetaldehyde	*B. pasteurianum* Neuberg and Simon, 1926
i-Amyl alc.	
methylethylacetaldehyde	*B. xylinum* Neuberg and Simon, 1926
methylethyl pyruvic ac.	yeast Neuberg and Peterson, 1914
l-Amyl alc.	
methylethylacetaldehyde	*B. ascendens* Neuberg and Simon, 1926
n-Amyl alc.	
glycerol	*B. butylicus* Morin, 1887
α-keto-n-caproic ac.	yeast Sen, 1923
n-valeraldehyde	yeast Neuberg and Nord, 1914
valeraldehyde	yeast Neuberg and Steenbock, 1914
Amylobiose	
starch	*Sacc. Saké* Sjöberg, 1927
Arabin	
raffinose, sucrose	*B. spongiosus* Ruhland, 1906
Arabonic ac.	
arabinose	sorbose bacterium Bertrand, 1898
Benzaldehyde	
phenylglyoxalic ac.	yeast Binder-Kotrba, 1926

Products Substrates	Microorganisms Authors
Benzoin	
benzil	yeast Neuberg and Nord, 1919
Benzyl alc.	
benzaldehyde	yeast Neuberg and Welde, 1914
2, 3-Butanediol	
See 2, 3-butyleneglycol	
Butyl alc.	
arabinose, dextrose, galactose, mannitol, starch, xylose	*B. granulobacter pectinovorum* Speakman, 1923
arabinose, xylose	*B. granulobacter pectinovorum* Peterson, Fred and Schmidt, 1924
dextrose	*B. granulobacter pectinovorum* *B. polymyxa* Donker, 1926
dextrose, glycerol, lactic ac., propionic ac.	*B. butylicus* Neuberg and Arinstein, 1921
glycerol	*B. butylicus* Buchner and Meisenheimer, 1908
glycerol	*B. butylicus* Morin, 1887
glycerol	*Mucor racemosus* Fitz, 1876
glycerol, lactic ac.	*Amylobacter butylicus* Duclaux, 1895
glycerol, mannitol	*Bact. butylicus* Emmerling, 1897
glycerol, mannitol, sucrose	*B. butylicus* Fitz, 1882
lactose maltose, mannitol, starch, sucrose	*Amylobacter butylicus* Duclaux, 1895

Products Substrates	Microorganisms Authors
Butyl alc. (cont.)	
starch	*Cl. acetobutylicum* Killeffer, 1927
starch	*Pectinobacter amylophilum* Makrinov, 1915
starch	*Granulobacter butylicum* Folpmers, 1921
β-Butylene glycol	
See 1, 3-butylene glycol	
1, 3-butylene glycol	
acetylmethyl carbinol	yeast Neuberg and Kobel, 1925
2, 3-butylene glycol	
acetaldehyde	*Bact. ascendens* Binder-Kotrba, 1926
acetaldehyde	*B. lactis aerogenes* Harden and Norris, 1912
acetaldol	yeast Neuberg and Kerb, 1918
adonitol, mannitol	*B. lactis aerogenes* Harden and Norris, 1912
arabinose, dextrose, galactose, isodulcite, mannose	*B. lactis aerogenes* Harden and Norris, 1912
arabinose, levulose, galactose, isodulcite, mannose	*B. cloacae* Harden and Norris, 1912
dextrose	*B. lactis aerogenes* Neuberg, Nord and Wolff, 1920
dextrose, levulose	*B. lactis aerogenes* Walpole, 1911
dextrose	*Serratia marcescens* Pederson and Breed, 1928

Products Substrates	Microorganisms Authors
2, 3,-butylene glycol (cont.)	
dextrose	*B. acetoethylicum* *B. polymyxa* *Cl. pasteurianum* *Granulobacter saccharobutyricum* Donker, 1926
dextrose	*B. aerogenes*, *B. cloacae* Scheffer, 1928
dextrose, levulose	yeast Kluyver, Donker and Hooft, 1925
dextrose, mannitol	*B. cloacae* Thompson, 1912
dextrose, mannitol	*B. lactis aerogenes* Harden and Walpole, 1906
ethylene glycol, glycerol	*B. lactis aerogenes* Harden and Norris, 1912
glycerol	*Bact. aerogenes* Braak, 1928
glycerol	*B. lactis aerogenes* Harden and Norris, 1912
lactic ac.	*B. mesentericus* Lemoigne, 1913
lactic ac.	*B. subtilis* Lemoigne, 1923
levulose	yeast Kluyver and Donker, 1924
oxalacetic ac.	yeast Neuberg and Gorr, 1924
sucrose	*B. subtilis* Lemoigne, 1912
sucrose	yeast Henninger, 1888
sucrose, xylose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930

Products Substrates	Microorganisms Authors
Butyric ac.	
arabinose, dextrose, galactose, mannitol, starch, xylose	*B. granulobacter pectinovorum* Speakman, 1923
butyl alc.	*B. Kützingianum* Mayer, 1898
butyl alc.	*B. pasteurianum* *B. Kützingianum* Seifert, 1897
butyl alc.	*Acetobacter melanogenum* visser't Hooft, 1925
cellulose	*Bact. cellaresolvens* *Bact. opalescens* Groenewege, 1923
cellulose	*Clostridium thermocellum* Viljoen, Fred and Peterson, 1926
cellulose	*B. cellulosae dissolvens* Khouvine, 1923
dextrose	*B. butylicus* Buchner and Meisenheimer, 1908
dextrose	*Bact. thermobutyricus* Coolhaas, 1928
dextrose	*B. granulobacter pectinovorum*, *Cl. pasteurianum* *Granulobacter saccharobutyricum* Donker, 1926
dextrose	*Cl. Pasteurianum* Winogradsky, 1902
dextrose, glycerol, lactic ac., propionic ac.	*B. butylicus* Neuberg and Arinstein, 1921
dextrose, glycerol	*B. subtilis* Vandevelde, 1884
glycerol, lactic ac.	*Amylobacter butylicus* Duclaux, 1895
glycerol, mannitol, sucrose	*B. butylicus* Fitz, 1882

Products Substrates	Microorganisms Authors
Butyric ac. (cont.)	
lactose, maltose, mannitol, starch, sucrose	*Amylobacter butylicus* Duclaux, 1895
levulose	*Sarcina maxima* Smit, 1928
starch	*B. suaveolens* Sclavo and Gosio, 1891
starch	*B. subtilis* Fitz, 1878
tartaric ac.	yeast Karczag, 1912
xylose	*B. paratyphoid* *B. typhosus* Fred and Peterson, 1920
Caproic ac.	
dextrose, glycerol, lactic ac., propionic ac.	*B. butylicus* Neuberg and Arinstein, 1921
Caprylic ac.	
dextrose, glycerol, lactic ac., propionic ac.	*B. butylicus* Neuberg and Arinstein, 1921
Cellobiose	
cellulose	*Bact. cellaresolvens* *Bact. opalescens* Groenwege, 1923
Cellulose	
dextrose, levulose, mannitol	*Bact. xylinum* Brown, 1886
Chlorobenzoic ac.	
chlorobenzaldehyde	yeast Neuberg and Liebermann, 1921
Chlorobenzyl alc.	
chlorobenzaldehyde	yeast Neuberg and Liebermann, 1921

Products Substrates	Microorganisms Authors
Cinnamic alc.	
cinnamic aldehyde	yeast Rona, 1914
Citric ac.	
arabinose, dextrose, galactose, glycerose, levulose, maltose, mannose, sucrose, xylose	*Asp. niger* Amelung, 1927
arabinose, glycerol, lactose, mannose, sucrose	*Citromyces*, sp.? Wehmer, 1913
arabinose, glycerol, mannitol, sucrose	*Asp. niger*, *Citromyces glaber* Butkewitsch, 1923
dextrose	*Asp. cinnamoneus* *Asp. fuscus* *Asp. niger* Falck and Kapur, 1924
dextrose	*Asp. niger* Wehmer, 1924
dextrose	*Asp. niger* Elfving, 1919
dextrose	*Citromyces*, sp.? Martin, 1916
dextrose	*Citromyces citricus* Buchner and Wüstenfeld, 1909
dextrose	*Citromyces glaber* Butkewitsch, 1922
dextrose	*Citromyces Pfefferianus* Buchner and Wüstenfeld, 1909
dextrose	*Mucor piriformis* *Penicillium luteum* Wehmer, 1897
dextrose	*Citromyces citricus* *Citromyces lacticus* *Citromyces oxalicus* *Citromyces tartricus* Mazé and Perrier, 1904
dextrose, gluconic ac., glyceric ac., glycerol, lactic ac., mannitol	*Asp. fumaricus* Schreyer, 1928

Products Substrates	Microorganisms Authors
Citric ac. (cont.)	
dextrose, sucrose	*Asp. niger* Bernhauer, 1928
ethyl alc.	*Citromyces citricus* *Citromyces tartricus* Mazé and Perrier, 1904
gluconic ac.	*Asp. niger* Walker, Subramaniam and Challenger, 1927
gluconic ac.	*Asp. fumaricus* Schreyer, 1925
glycerol	*Citromyces citricus* Mazé and Perrier, 1904
saccharic ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
sucrose	*Asp. niger* Bernhauer, 1926
sucrose	*Asp. niger* Butkewitsch, 1924
sucrose	*Asp. niger* Bernhauer, 1924
sucrose	*Asp. niger* Currie, 1917
sucrose	*Citromyces*, sp.? Filosofov and Malinovski, 1928
sucrose	*Citromyces*, sp.? Mazé, 1909
sucrose	*Asp. fumaricus* Wehmer, 1918, 1928
sucrose	*Citromyces citricus* *Citromyces glaber* *Citromyces Pfefferianus* *Penicillium glaucum* Butkewitsch, 1922

Products Substrates	Microorganisms Authors
Citric ac. (cont.)	
sucrose	*Citromyces glaber* *Penicillium glaucum* Butkewitsch, 1927
sucrose	*Sterigmatocystis nigra* Molliard, 1922
Citronella Oil (or alc.)	
α-citronellaldehyde	yeast Mayer and Neuberg, 1915
Dextrin	
dihydroxyacetone	*S. ludwigii* Neuberg and Kobel, 1928
starch	*B. amylobacter* Villiers, 1891
Dextrose	
starch	*B. anthracis* Maumus, 1893
phloridzin	*Asp. niger* *Cladosporium*, sp.? Boas, 1916
α, α, dichlorpropyl alc.	
α, α, dichloracetone	yeast Sen, 1924
gluconic ac.	*Acetobacter sp?* Söhngen, 1914, 1915
Dihydroxyacetone	
glycerol	*Acetobacter suboxydans* Kluyver and deLeeuw, 1924
glycerol	sorbose bacterium Bertrand, 1904
glycerol	*B. xylinum* Bernhauer and Schön, 1928
glycerol	*B. dioxyacetonicum* *B. xylinum* Virtanen and Barlund, 1926

Products Substrates	Microorganisms Authors
Dihydroxyacetone (cont.)	
glycerol	*Acetobacter suboxydans* *Bact. xylinum* Brit. patent 269,950
glycerol	*Bact. xylinum* Bertrand and Sazerac, 1901
glycerol	sorbose bacterium Bertrand, 1898
Erythrose	
erythritol	*Acetobacter suboxydans* Kluyver and deLeeuw, 1924
Erythrulose	
erythritol	Sorbose bacterium Bertrand, 1898, 1900
Ethyl alc.	
acetaldehyde	yeast Kostytschew and Hübbenet, 1912
arabinose	*B. ethaceticus* Frankland and MacGregor, 1892
arabinose, dextrin, dextrose, galactose, glycerol, lactic ac., levulose, maltose, mannose, raffinose, starch, sucrose, xylose	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
arabinose, dextrose, galactose, levulose, mannitol	*B. coli communis* Harden, 1901
cellulose	*Clostridium thermocellum* Viljoen, Fred and Peterson, 1926
cellulose	*B. cellulosae dissolvens* Khouvine, 1923
citric ac.	*B. coli communis* Grey, 1923
dextrin, starch	*Mucor circinelloides* (?) Gayon and Dubourg, 1886

Products Substrates	Microorganisms Authors
Ethyl alc. (cont.)	
dextrose	*Asp. niger* Kostytschew, 1907
dextrose	*B. coli communis* Grey and Young, 1921
dextrose	*B. aerogenes* *B. coli* Virtanen and Simola, 1927
dextrose	*B. coli* Grimbert, 1896
dextrose	*B. coli communis* Harden, 1899
dextrose	*B. dysenteriae*, Shiga-Kruse Bergh, 1928
dextrose	*B. aectoethylicum* *B. granulobacter pectinovorum* Weizmann *B. polymyxa* *Clostridium pasteurianum* Donker, 1926
dextrose	*B. aerogenes* *B. cloacae* *B. coli* *B. dysenteriae*, Shiga-Kruse *B. Freundii* *B. typhosus* Scheffer, 1928
dextrose	*Oidium lupuli* Sumiki, 1927
dextrose	*Rhizopus*, sp.? Takahashi and Sakaguchi, 1927
dextrose	yeast Rimini, 1926
dextrose	*B. coli communis* Grey, 1918

Products Substrates	Microorganisms Authors
Ethyl alc. (cont.)	
dextrose	*B.* of malignant oedema Kerry and Frankel, 1890
dextrose	Friedlander's pneumococcus Frankland, Stanley and Frew, 1891
dextrose	*Rhizopus*, sp.? Nill, 1927
dextrose	*Fusarium lini* Anderson and Willaman, 1922
dextrose	*B. typhosus* Harden, 1901
dextrose	*Serratia marcescens* Pederson and Breed, 1928
dextrose, galactose, mannose	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
dextrose, gluconic ac., glycerol, mannitol	*B. coli communis* Kay, 1926
dextrose, gluconic ac., mannitol	*B. lactis aerogenes* Kay, 1926
dextrose, lactose, maltose, mannitol, sucrose	*B. tartricus* Grimbert, 1901
dextrose, levulose	*Bact. pyocyaneus* Aubel, 1921
dextrose, levulose	*Sarcina maxima* *Sarcina ventriculi* Smit, 1928
dextrose, maltose	*B. acetoethylicum* Speakman, 1925
dextrose, mannitol	*B. coli communis* Grey, 1918
dextrose, mannitol	*B. cloacae*, *B. coli* *B. lactis aerogenes* Thompson, 1912
dextrose, mannitol	*B. ethaceticus* Frankland and Lumsden, 1892

Products Substrates	Microorganisms Authors
Ethyl alc. (cont.)	
dextrose, mannitol	*B. lactis aerogenes* Harden and Walpole, 1906
dextrose, starch, sucrose	*B. acetoethylicum* Arzberger, Peterson and Fred, 1920
dextrose, sucrose	*Mucor mucedo* *Mucor racemosus* *Mucor stolonifer* Kostytschew and Eliasberg, 1920
dulcitol	Pneumobacillus of Friedländer Grimbert, 1896
gluconic ac.	*Acetobacter*, sp.? Söhngen, 1914, 1915
glyceric ac.	yeast Lebedev, 1918
glycerol	*B. coli communis* Grey, 1923
glycerol	*Bact. aerogenes* *Bact. coli* *Bact. Freundii* Braak, 1928
glycerol	*B. lactis aerogenes* Harden and Norris, 1912
glycerol	*Mucor racemosus* Fitz, 1876
glycerol	yeast Neuberg and Kerb, 1913
glycerol, mannitol	yeast Kostytschew and Faermann, 1928
i-inositol	*B. lactis* Hewitt and Steabben, 1921
ketobutyric ac.	yeast Neuberg and Kerb, 1914

Products Substrates	Microorganisms Authors
Ethyl Alc. (cont.)	
lactic ac.	*B. ethacetosuccinicus* Mazé, 1913
lactic ac.	yeast Kayser, 1923
lactose	*B. coli* Grimbert, 1896
lactose, maltose, mannitol, starch, sucrose	*Amylobacter butylicus* Duclaux, 1895
malic ac.	*B. coli communis* Grey, 1923
malonic ac.	*B. coli communis* Grey, 1923
mannitol	Pneumobacillus of Friedländer Grimbert, 1896
mannitol	*B. ethaceticus* Frankland, Stanley and Frew, 1891
mannitol, glycerol	*B. ethaceticus* Frankland and Fox, 1889
mannose	yeast Mezzadroli, 1918
pyruvic ac.	yeast Neuberg and Kerb, 1913
pyruvic ac.	yeast Lebedev and Polonski, 1917
starch	*Granulobacterium butylicum* Folpmers, 1921
starch	*Clostridium acetobutylicum* Killeffer, 1927
starch, sucrose	*B. acetoethylicus* *B. macerans* Bakonyi, 1926
sucrose	*Amylobacter ethylicus* Duclaux, 1895
sucrose	*B. invertenti-acetici* Mezzadroli, 1917

Products Substrates	Microorganisms Authors
Ethyl alc. (cont.)	
sucrose	*Mucor racemosus* Emmerling, 1897
sucrose	*Mucor racemosus* Fitz, 1876
sucrose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
sucrose	*Mucor mucedo* Fitz, 1873
sucrose	yeast Gehle, 1922
sucrose	*Sacc. Saké* *Zygosacc. major* *Zygosacc. salsus* Kumagawa, 1922
sucrose	*Penicillium glaucum* Kostytschew and Afanassjewa, 1922
tartaric ac.	*B. coli communis* Grey, 1923
xylose	*Acetobacter xylinum*, *B. vulgatus* Fred, Peterson and Anderson, 1923
xylose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
xylose	*B. lactis aerogenes* *B. paratyphoid* *B. typhosus* Fred and Peterson, 1920
xylose	Pneumobacillus of Friedländer Grimbert, 1896
Ethylene glycol	
glycolaldehyde	yeast Neuberg and Schwenk, 1915

Products Substrates	Microorganisms Authors
Ethyl mercaptan	
ethyl disulfide	yeast Neuberg and Schwenk, 1915
thioacetaldehyde	yeast Neuberg and Nord, 1914
Formaldehyde	
acetic ac.	*B. pyocyaneus* Supniewski, 1923
Formic ac.	
acetic ac., acetone	*B. pyocyaneus* Supniewski, 1923
arabinose, dextrin, dextrose, galactose, glycerol, lactic ac., levulose, maltose, mannose, raffinose, starch, sucrose, xylose	*B. acetoethylicum* Northrop, Ashe and Morgan, 1919
dextrose	*B. aerogenes*, *B. coli* Virtanen and Simola, 1927
dextrose	*B. coli communis* Grey, 1918
dextrose	*B. coli communis* Franzen and Kahlenberg, 1916
dextrose	*B. coli communis* Grey and Young, 1921
dextrose	*B. prodigiosus* Franzen and Egger, 1924
dextrose	*B. typhosus* Harden, 1901
dextrose	Friedländer's pneumococcus Frankland, Stanley and Frew, 1891
dextrose	*Serratia marcescens* Pederson and Breed, 1928
dextrose	*B. dysenteriae*, Shiga-Kruse Bergh, 1928

Products Substrates	Microorganisms Authors
Formic ac. (cont.)	
dextrose	*B. acetoethylicum* *B. granulobacter pectinovorum*, Weizmann *Clostridium pasteurianum* *Granulobacter saccharobutyricum* Donker, 1926
dextrose	*B. aerogenes* *B. cloacae* *B. coli* *B. dysenteriae* , Shiga-Kruse *B. Freundii* *B. polymyxa* *B. typhosum* Scheffer, 1928
dextrose, gluconic ac., glycuronic ac., mannitol, saccharic ac.	*B. coli communis* Kay, 1926
dextrose, gluconic ac., mannitol, saccharic ac.	*B. lactis aerogenes* Kay, 1926
dextrose, levulose	*Bact. pyocyaneus* Aubel, 1921
dextrose, levulose	*Sarcina maxima* *Sarcina ventriculi* Smit, 1928
dextrose, mannitol	*B. cloacae*, *B. coli* *B. lactis aerogenes* Thompson, 1912
dextrose, mannitol	*B. lactis aerogenes* Harden and Walpole, 1906
dextrose, starch, sucrose	*B. acetoethylicum* Arzberger, Peterson and Fred, 1920
glycerol	*Bact. aerogenes* *Bact. coli* *Bact. Freundii* Braak, 1928

Products Substrates	Microorganisms Authors
Formic ac. (cont.)	
glycerol	*B. butylicus* Buchner and Meisenheimer, 1908
glycerol	*B. lactis aerogenes* Harden and Norris, 1912
glycerol	*B. coli communis* Grey, 1923
lactic ac.	*B. ethacetosuccinicus* Mazé, 1913
mannitol, glycerol	*B. ethaceticus* Frankland and Fox, 1889
methyl alc.	*B. pyocyaneus* Supniewski, 1923
pyruvic ac.	*B. coli*, *B. pyocyaneus* Cambier and Aubel, 1922
pyruvic ac.	*Bact. coli* Aubel, 1924
quinic ac.	Schizomycetes Loew, 1881
starch	*Pectinobacter amylophilum* Makrinov, 1915
starch	*B. suaveolens* Sclavo and Gosio, 1891
succinic ac.	*B. coli communis* Grey, 1923
sucrose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
xylose	*B. paratyphoid* *B. typhosus* Fred and Peterson, 1920
xylose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930

Products Substrates	Microorganisms Authors
Fumaric ac.	
arabinose, galactose	*Asp. fumaricus* Schreyer, 1928
dextrose, levulose	*Rhizopus nigricans* Ehrlich, 1912
malic ac., succinic ac.	*B. coli communis* Quastel and Whetham, 1924
pyruvic ac.	*Rhizopus nigricans* Gottschalk, 1925
sucrose	*Asp. fumaricus* Wehmer, 1918, 1928
Furfuryl alc.	
furfural	yeast Lintner and Liebig, 1911
Furyltrimethyleneglycol	
furfural	yeast Lintner and Liebig, 1913
Galactonic ac.	
galactose	sorbose bacterium Bertrand, 1898
Geraniol	
citral	yeast Neuberg and Kerb, 1918
α-Glucoheptulose	
α-glucoheptite	Sorbose bacterium Bertrand and Nitzberg, 1928
Gluconic ac.	
arabinose, dextrose, glycerol, levulose, mannose, sucrose	*Asp. niger* Bernhauer, 1928
dextrose	*Asp. cinnamoneus* *Asp. fuscus* *Asp. niger* Falck and Kapur, 1924
dextrose	*Bact. aceti* Brown, 1886

Products Substrates	Microorganisms Authors
Gluconic ac. (cont.)	
dextrose	*Acetobacter*, sp.? Day and Walker, 1913 Söhngen, 1914, 1915
dextrose	*Bact. aceti viscosum* Day and Walker, 1913
dextrose	*B. Kützingianum* Seifert, 1897 *B. Pasteurianum* Mayer, 1898
dextrose	*B. xylinum* Bernhauer and Schön, 1929
dextrose	*Bact. acetigenum* *Bact. acetosum* *Bact. oxydans* Henneberg, 1909
dextrose	*Penicillium purpurogenum* May, Thom and Church, 1927
dextrose	*Asp. niger* Bernhauer, 1928
dextrose	*Asp. niger* Müller, 1925
dextrose	*Mycoderma aceti* Boutroux, 1880
dextrose	*Penicillium purpurogenum* Herrick and May, 1928
dextrose	Sorbose bacterium Bertrand, 1898
sucrose	*Asp. niger* Bernhauer, 1926
sucrose	*Citromyces glaber* *Penicillium glaucum* Butkewitsch, 1927
sucrose	*Asp. fumaricus* Wehmer, 1928
sucrose	*Asp. niger* Butkewitsch, 1924

Products Substrates	Microorganisms Authors
Gluconic ac. (cont.)	
sucrose	*Asp. niger* Bernhauer, 1924, 1926
Glyceric ac.	
glycerol	*B. pyocyaneus* Supniewski, 1923
Glycerol	
dextrose	yeast Oppenheimer, 1913
dextrose, sucrose	yeast Neuberg and Hirsch, 1919
galactose	yeast Tomita, 1921
sucrose	*Mucor racemosus* Emmerling, 1897
sucrose	*Sacc. ellipsoideus* Adams, 1919
sucrose	*Sacc. Saké*, *Zygosacc. major* *Zygosacc. salsus* Kumagawa, 1922
sucrose	*Sterigmatocystis nigra* Molliard, 1922
sucrose	yeast Zerner, 1920
sucrose	yeast Abderhalden and Stix, 1922
sucrose	yeast Gehle, 1922
sucrose	yeast Neuberg and Reinfürth, 1923
sucrose	yeast Buchner and Meisenheimer, 1906
sucrose	yeast Tomoda, 1928

Products Substrates	Microorganisms Authors
Glycogen	
dextrose	*Sacc. Ludwigii* Gottschalk, 1925
Glycolaldehyde	
dihydroxymaleic ac.	yeast Neuberg and Schwenk, 1915
hydroxy-pyruvic ac.	yeast Neuberg and Kerb, 1913
Glycollic ac.	
acetic ac., citric ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
ethylene glycol	*B. Kützingianum* Seifert, 1897
ethylene glycol	*B. Pasteurianum* Mayer, 1898
oxalic ac., pyruvic ac.	*B. coli* *B. proteus vulgatus* Cambier and Aubel, 1922
pyruvic ac.	*Bact. coli* Aubel, 1924
n-Heptyl alc.	
enanthol	yeast Ohta, 1914
n-Hexyl alc.	
caproic aldehyde	yeast Neuberg and Nord, 1914
β-Hydroxybutyric ac.	
acetaldol	*B. ascendens* Binder-Kotrba, 1926
butyric ac.	*Asp. niger* Coppock, Walker and Subramaniam, 1928
Isobutyl Alc.	
iso-butylaldehyde	yeast Ohta, 1914

Products Substrates	Microorganisms Authors
Isobutylaldehyde	
α-keto-isovaleric ac.	yeast Sen, 1923
Isobutyric ac.	
isobutyl alc.	*Acetobacter melanogenum* Visser't Hooft, 1925
Ketogluconic ac.	
dextrose	*B. xylinum* Bernhauer and Schön, 1929
Keto-heptose	
arabitol, volemitol	sorbose bacterium Bertrand, 1898
Keto-stearic ac.	
oleic ac.	*Pen. glaucum* Pigulewski and Charik, 1928
Lactic ac.	
arabinose	*Lactobacillus arabinosus* Fred, Peterson and Anderson, 1921
arabinose	Pneumobacillus of Friedländer Grimbert, 1896
arabinose, dextrose, galactose, levulose, mannitol	*B. coli communis* Harden, 1901
arabinose, dextrose, galactose, mannitol, starch, xylose	*B. granulobacter pectinovorum* Speakman, 1923
arabinose, xylose	*Lactobacillus pentosus* *Lactobacillus pentoaceticus* Fred, Peterson and Anderson, 1921
cellulose	*Bact. cellaresolvens* *Bact. opalescens* Groenewege, 1923
dextrose	*B. aerogenes*, *B. coli* Virtanen and Simola, 1927
dextrose	*B. coli communis* Goto, 1925
dextrose	*B. coli communis* Grey and Young, 1921

Products Substrates	Microorganisms Authors
Lactic ac. (cont.)	
dextrose	*B. coli communis* Grey, 1918, 1920
dextrose	*B. coli communis* Young, 1924
dextrose	*Serratia marcescens* Pederson and Breed, 1928
dextrose	*B. typhosus* Harden, 1901
dextrose	*B. casei* Virtanan and Karström, 1928
dextrose	*B. acetoethylicum* *B. granulobacter pectinovorum*, Weizmann *B. polymyxa* *Granulobacter saccharobutyricum* Donker, 1926
dextrose	*B. coli* Grimbert, 1886
dextrose	*B. coli communis* Harden, 1899
dextrose	*B. coli* *B. propionicus* *Lactobacillus*, sp.? Neuberg and Gorr, 1926
dextrose	*B. aerogenes* *B. cloacae* *B. coli* *B. dysenteriae*, Shiga-Kruse *B. Freundii* *B. typhosum* Scheffer, 1928
dextrose	*B. butylicus* Buchner and Meisenheimer, 1908
dextrose	*Lactobacillus leichmanni* Allgeier and Peterson, 1930

Products Substrates	Microorganisms Authors
Lactic ac. (cont.)	
dextrose	*B. coli* Péré, 1898
dextrose	*Rhizopus chinensis* Saito, 1911
dextrose	B. of malignant oedema King and Frankel, 1890
dextrose	*Streptococcus lactis* Algeier and Peterson, 1930
dextrose	yeast Aubel, 1929
dextrose, dextrin, maltose, sucrose	*B. Delbrücki* *B. lactis acidi* Henneberg, 1903
dextrose, dihydroxyacetone, glyceraldehyde	yeast Oppenheimer, 1913
dextrose, galactose, mannose	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
dextrose, gluconic ac., glycuronic ac., mannitol, saccharic ac.	*B. coli communis* Kay, 1926
dextrose, gluconic ac., mannitol, saccharic ac.	*B. lactis aerogenes* Kay, 1926
dextrose, glycerol	*B. subtilis* Vandevelde, 1884
dextrose, lactose, maltose, mannitol, sucrose	*B. tartricus* Grimbert, 1901
dextrose, levulose	*Clostridium thermocellum* Peterson, Fred and Marten, 1926
dextrose, levulose	*Sarcina maxima* *Sarcina ventriculi* Smit, 1928
dextrose, mannitol	*B. coli communis* Grey, 1918

Products Substrates	Microorganisms Authors
Lactic ac. (cont.)	
dextrose, mannitol	*B. cloacae*, *B. coli* *B. lactis aerogenes* Thompson, 1912
dextrose, mannitol	*B. lactis aerogenes* Harden and Walpole, 1906
dextrose, starch, sucrose	*B. acetoethylicum* Arzberger, Peterson and Fred, 1920
galactose	*B. coli* Péré, 1898
glycerol	*Bact. aerogenes* *B. coli* *B. Freundii* Braak, 1928
glycerol	*B. lactis aerogenes* Harden and Norris, 1912
glycerol	*B. pyocyaneus* Supniewski, 1923
glycerol	*B. coli communis* Grey, 1923
glycerol	*B. butylicus* Buchner and Meisenheimer, 1908
inositol	*B. lactis aerogenes* Kumagawa, 1922
lactose	*Bact. caucasicum* Kostytschew and Soldatenkov, 1927
lactose	*B. coli* Grimbert, 1896
lactose	*B. coli* Péré, 1898
lactose	*B. lactis acidi* Henneberg, 1903
lactose, maltose, mannitol, starch, sucrose	*Amylobacter butylicus* Duclaux, 1895

Products Substrates	Microorganisms Authors
Lactic ac. (cont.)	
levulose	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
levulose	*Bact. pyocyaneus* Aubel, 1921
malic ac.	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
malic ac.	yeast Lebedev and Russ, 1916
malonic ac.	*B. coli communis* Grey, 1925
mannitol	*B. coli* Péré, 1898
mannitol	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
mannitol	Pneumobacillus of Friedländer Grimbert, 1896
mannose	*B. coli* Péré, 1898
methylglyoxal	*Bact. pasteurianum* Gorr and Perlman, 1926
methylglyoxal	*Bact. coli* Neuberg and Gorr, 1925
methylglyoxal	*B. coli* *B. propionicus* *Lactobacillus*, sp.? Neuberg and Gorr, 1927
methylglyoxal	*B. Delbrücki* *Bact. lactis aerogenes* Neuberg and Simon, 1927
methylglyoxal	yeast Neuberg and Kobel, 1927, 1929
methylglyoxal	yeast Neuberg, 1913
methylglyoxal	yeast Dakin and Dudley, 1913

Products Substrates	Microorganisms Authors
Lactic ac. (cont.)	
d-propylene glycol	*Bact. termo* LeBel, 1881
pyruvic ac.	*B. coli*, *B. proteus vulgatus* Cambier and Aubel, 1922
pyruvic ac.	*Bact. coli* Aubel, 1924
pyruvic ac.	*B. pyocyaneus* Aubel, 1924
pyruvic ac.	*Oidium albicans* *O. farinosum* *O. gueraldi* *O. tenuis* Mazé and Ruot, 1917
pyruvic ac.	*Rhizopus nigricans* Gottschalk, 1925
starch	*Pectinobacter amylophilum* Makrinov, 1915
sucrose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
sucrose	*Amylobacter ethylicus* Duclaux, 1895
sucrose	*B. acidi laevolactici* Schardinger, 1890
sucrose	*B. casei E* Virtanen, Wichmann and Lindström, 1927
sucrose	*B. coli* Virtanen and Simola, 1927
sucrose	*B. coli* Péré, 1898
sucrose	*B. invertenti-lattici* *B. invertenti-acetici* Mezzadroli, 1917

Products Substrates	Microorganisms Authors
Lactic ac. (cont.)	
sucrose	*Strept. lactis* Virtanen, Wichmann and Lindström, 1927
sucrose	yeast Fernbach and Schoen, 1923
d-tartaric ac.	yeast Karczag, 1912
xylose	*Lactobacillus pentoaceticus* Fred, Peterson and Davenport, 1919
xylose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
xylose	*B. lactis aerogenes* *B. paratyphoid* *B. typhosus* Fred and Peterson, 1920
xylose	Pneumobacillus of Friedländer Grimbert, 1896
Levulose	
mannitol	*Acet. suboxydans* Kluyver and deLeeuw, 1924
mannitol	Sorbose bacterium Bertrand, 1898
mannitol	*Bact. aceti* Brown, 1886
mannitol	*B. xylinum* Hoyer, 1898
Malic ac.	
fumaric ac.	*Asp. niger* Challenger and Klein, 1929
oxalacetic ac.	yeast Neuberg and Gorr, 1924
sucrose	*Asp. fumaricus* Wehmer, 1928
sucrose	yeast Kostytschew and Frey, 1925

Products Substrates	Microorganisms Authors
Malic ac. (cont.)	
sucrose	yeast Dakin, 1924
Mandelic ac.	
phenylglyoxal	yeast Dakin and Dudley, 1913
phenylglyoxal	*Lactobacillus*, sp.? Mayer, 1926
Mannitol	
dextrose	*B. subtilis* Vandevelde, 1884
levulose	*Lactobacillus pentoaceticus* Peterson and Fred, 1920
Methylethylacetaldehyde	
methylethyl pyruvic ac.	yeast Neuberg and Peterson, 1914
d-methylethylcarbinol	
methylethylketone+sucrose	yeast Neuberg and Nord, 1919
d-methylhexylcarbinol	
methyl-n-hexylketone+sucrose	yeast Neuberg and Nord, 1919
d-methylnonylcarbinol	
methylnonylketone+sucrose	yeast Neuberg and Nord, 1919
d-methyl-n-propylcarbinol	
methyl-n-propyl ketone+ sucrose	yeast Neuberg and Nord, 1919
p-methoxybenzoic ac.	
p-methoxybenzaldehyde	yeast Neuberg and Liebermann, 1921
p-methoxybenzyl alc.	
p-methoxybenzaldehyde	yeast Neuberg and Liebermann, 1921

Products Susbtrates	Microorganisms Authors
Methyl alc.	
formaldehyde	yeast Neuberg and Welde, 1914
Methylchlorethyl alc.	
methylchlorethyl ketone	yeast Santomauro, 1924
o-methylcyclohexanol	
o-methylcyclohexanone	yeast Akamatsu, 1923
Methyl acetol	
See acetylmethyl carbinol	
Methylglyoxal	
lactose	*Bact. caucasicum* Kostytschew and Soldatenkov, 1927
sucrose	*B. coli* Virtanen and Simola, 1927
Methylphenylethylene glycol	
methylbenzoyl carbinol	yeast Neuberg and Komarewsky, 1927
Oxalic ac.	
acetic ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927
acetic ac., arabinose, dextrose, ethylene glycol, galactose, glycerol, glycollic ac., lactic ac., malonic ac.	*Termobacterium aceti* Banning, 1902
acetic ac., dextrose, erythritol, ethylene glycol, isolichenin, mannitol	*B. industrium* Banning, 1902
acetic ac., dextrose, erythritol, ethylene glycol, glycerol, levulose	*B. oxydans* Banning, 1902
acetic ac., dextrose, starch, tartaric ac.	*Asp. niger* Wehmer, 1891

Products Substrates	Microorganisms Authors
Oxalic ac. (cont.)	
acetic ac., fumaric ac., malic ac., succinic ac., tartaric ac.	*Asp. niger* Raistrick and Clark, 1919
acetonedicarboxylic ac.	*Asp. niger* Walker, Subramaniam and Challenger, 1927
arabinose, dextrose, glycollic ac.	*B. acetigenum* Banning, 1902
arabinose, dextrin, dextrose, ethylene glycol, galactose, glycollic ac., isobutyric ac. isolichenin, lactic ac., malonic ac.	*B. Kützingianum* Banning, 1902
arabinose, dextrin, dextrose, erythritol, ethylene glycol, glycollic ac., malonic ac.	*B. acetosum* Banning, 1902
arabinose, dextrose, ethylene-glycol, glycerol, glycollic ac., malonic ac., rhamnose	*B. ascendens* Banning, 1902
arabinose, dextrose, glycerol, levulose, rhamnose	*B. xylinum* Banning, 1902
arabinose, dextrose, erythritol, ethylene glycol, glycerol, glycollic ac., isobutyric ac., isolichenin, levulose, malonic ac., rhamnose	*B. aceti* Banning, 1902
arabinose, dextrose, galactose, glycerose, levulose, maltose, mannose, sucrose, xylose	*Asp. niger* Amelung, 1927
arabinose, gluconic ac., glycerol, mannitol, saccharic ac., sucrose	*Asp. niger*, *Citromyces glaber* Amelung, 1927
citric ac.	*Citromyces glaber* Butkewitsch, 1922
citric ac.	*Asp. niger* Challenger, Subramaniam and Walker, 1927

Products Substrates	Microorganisms Authors
Oxalic ac. (cont.)	
dextrin, dextrose, ethylene glycol, glycerol, glycollic ac., isobutyric ac., malonic ac., sucrose	*B. Pasteurianum* Banning, 1902
dextrin, dextrose, glycerol, inulin, lactose, mannitol, sucrose	*Asp. niger* Elfving, 1919
dextrose	*Asp. niger* Wehmer, 1897, 1924
dextrose	*Asp. niger* Heinze, 1903
dextrose	*Citromyces glaber* Butkewitsch, 1922
ethyl alc.	*Citromyces citricus* *Citromyces tartricus* Mazé and Perrier, 1904
raffinose	*Asp. niger* Gillot, 1899
sucrose	*Asp. niger* Bernhauer, 1926
sucrose	*Asp. niger* Currie, 1917
sucrose	*Asp. niger* Butkewitsch, 1923, 1924
sucrose	*Asp. niger* Bernhauer, 1924
sucrose	*Citromyces citricus* *Citromyces glaber*, *Citromyces Pfefferianus*, *Penicillium glaucum* Butkewitsch, 1922
sucrose	*Sterigmatocystis nigra* Molliard, 1922
β-oxybutyric ac.	
acetaldol	*Bact. ascendens* Binder-Kotrba, 1926

Products Substrates	Microorganisms Authors
Oxygluconic ac.	
gluconic ac.	*Acetobacter suboxydans* Kluyver and deLeeuw, 1924
dextrose	*Micrococcus oblongus* Boutroux, 1886
Oxymaltol	
glycerol	*Asp. glaucus* Traetta-Mosca and Preti, 1921
Perseulose	
perseitol	Sorbose bacterium Bertrand, 1898
d-perseitol	*Bact. xylinum* Bertrand, 1909
l-phenylacetylcarbinol	
benzaldehyde	yeast Neuberg and Ohle, 1923
Phenylethyl alc.	
phenylacetaldehyde	yeast Neuberg and Welde, 1914
l-phenylmethylcarbinol	
acetophenone+sucrose	yeast Neuberg and Nord, 1919
Phloroglucinol	
phloridzin	*Asp. niger*, *Cladosporium*, sp.? Boas, 1916
Phenylpropylaldehyde	
benzylpyruvic ac.	yeast Rona, 1914
Propionaldehyde	
α-ketobutyric ac.	yeast Neuberg and Kerb, 1912, 1913
Propionic ac.	
arabinose, xylose	*Propionibacterium pentosaceum* Werkman, Hixon, Fulmer and Rayburn, 1929
dextrose	*Diplococcus pneumoniae* Brieger, 1883

Products Substrates	Microorganisms Authors
Propionic ac. (cont.)	
dextrose, glycerol, lactic ac.	*Propionibacterium Freudenreichii* *Propionibacterium Jensenii* *Propionibacterium pentosaceum* *Propionibacterium Peterssonii* *Propionibacterium rubrum* *Propionibacterium Shermanii* *Propionibacterium technicum* *Propionibacterium Thonii* van Niel, 1928
dextrose, lactic ac., lactose, pyruvic ac.	*Bact. acidi propionici* Virtanen, 1923
lactic ac.	*B. acidi propionici* *B. acidi propionici-a* *B. acidi propionici-b* von Freudenreich and Jensen, 1906
lactic ac.	*B. subtilis* Fitz, 1880
lactic ac.	*B. casei* *B. mobilis* *Micrococcus casei liquefaciens* Orla-Jensen, 1904
lactose	*Bact. acidi propionici* Sherman and Shaw, 1923
propyl alc.	*Bact. aceti* Brown, 1886
propyl alc.	*Acetobacter*, sp.? *B. aceti* (Hansen) Buchner and Gaunt, 1906
propyl alc.	*B. Kützingianum* *B. Pasteurianum* Mayer, 1898
d-propyleneglycol	*Bact. termo* LeBel, 1881
pyruvic ac.	*Bact. coli* Aubel, 1924

Products Substates	Microorganisms Authors
Propionic ac. (cont.)	
quinic ac.	Schizomycetes Loew, 1881
succinic ac.	*B. pyocyaneus* Quastel, 1924
succinic ac.	*B casei* Orla-Jensen, 1904
tartaric ac.	*Bact. termo* König, 1881
d-tartaric ac.	yeast Karczag, 1912
Propyl alc.	
glycerol	*B. butylicus* Morin, 1887
α-ketobutyric ac.	yeast Neuberg and Kerb, 1914
starch	*Granulobacterium butylicum* Folpmers, 1921
Protocatechuic ac.	
quinic ac.	*Micrococcus chinicus* Emmerling and Abderhalden, 1903
quinic ac.	Schizomycetes Loew, 1881
quinic ac.	*Asp. niger*, *Asp. oryzae* *Citromyces glaber* Butkewitsch, 1924
Pyrocatechol	
quinic ac.	*Asp. niger*, *Asp. oryzae* *Citromyces glaber* Butkewitsch, 1924
Pyroracemic ac.	
See pyruvic ac.	
Pyruvic ac.	
dextrose	*B. coli* Aubel, 1926

Products Substrates	Microorganisms Authors
Pyruvic ac. (cont.)	
dextrose	*Mycoderma*, sp.? Fernbach and Schoen, 1914
dextrose	yeast Fernbach and Schoen, 1920
dextrose, maltose	*B. acetoethylicum* Speakman, 1925
fumaric ac.	*B. pyocyaneus* Quastel, 1924
fumaric ac.	*B. pyocyaneus* Quastel, Stephenson and Whetham, 1925
glycerol	*B. subtilis* Aubel, 1921
lactic ac.	*Amylomyces rouxii* Mazé and Ruot, 1916
lactic ac.	*B. coli communis* *B. pyocyaneus* Quastel, Stephenson and Whetham, 1925
lactic ac.	*B. pyocyaneus* Supniewski, 1923
lactic ac.	*Oidium albicans*, *O. farinosum* *O. gueraldi*, *O. tenuis* Mazé and Ruot, 1917
lactic ac.	yeast Kayser, 1923
lactose	*Bact. caucasicum* Kostytschew and Soldatenkov, 1927
malic ac.	*B. fluorescens* Beijerinck, 1916
sucrose	yeast Fernbach and Schoen, 1913
sucrose	yeast Kostytschew and Soldatenkov, 1928

Products Substrates	Microorganisms Authors
Saccharic ac.	
gluconic ac.	*Asp. niger* Walker, Subramaniam and Challenger, 1927
Sorbose	
sorbitol	*Acetobacter suboxydans* Kluyver and deLeeuw, 1924
sorbitol	*B. xylinum* Seifert, 1897, Mayer, 1898
d-sorbitol	Sorbose bacterium Bertrand, 1898
Styrol	
cinnamic ac.	*Asp. niger* Herzog and Ripke, 1908
Succinic ac.	
acetaldehyde	*B. lactis aerogenes* Harden and Norris, 1912
aldehydropropionic ac.	yeast Neuberg and Ringer, 1918
arabinose	*B. ethaceticum* Frankland and MacGregor, 1892
arabinose, dextrose, galactose, levulose, mannitol	*B. coli communis* Harden, 1901
citric ac.	*B. coli communis* Grey, 1923
citric ac.	*B. suipestifer* Brown, Duncan and Henry, 1924
dextrose	*B. dysenteriae*, Shiga-Kruse Bergh, 1928
dextrose	*B. aerogenes* *B. coli* *B. dysenteriae*, Shiga-Kruse *B. Freundii* *B. typhosum* Scheffer, 1928

Products Substrates	Microorganisms Authors
Succinic ac. (cont.)	
dextrose	*B. aerogenes*, *B. coli* Virtanen and Simola, 1927
dextrose	*B. coli communis* Grey and Young, 1921
dextrose	*B. coli communis* Grey, 1918
dextrose	*B. coli communis* Young, 1924
dextrose	*B. typhosus* Harden, 1901
dextrose	*Oidium lupuli* Sumiki, 1927
dextrose	*Serratia marcescens* Pederson and Breed, 1928
dextrose, gluconic ac., glycuronic ac., mannitol, saccharic ac.	*B. coli communis* Kay, 1926
dextrose, gluconic ac., mannitol, saccharic ac.	*B. lactis aerogenes* Kay, 1926
dextrose, glycerol, lactic ac.	*Propionibacterium Freudenreichii* *Propionibacterium pentosaceum* *Propionibacterium Peterssonii* *Propionibacterium rubrum* *Propionibacterium Shermanii* *Propionibacterium Thonii* van Niel, 1928
dextrose, glycerol, lactic ac., pyruvic ac., starch	*Propionibacterium technicum* van Niel, 1928
dextrose, glycerol, lactic ac.	*Propionibacterium Jensenii* van Niel, 1928
dextrose, lactose	*Bact. acidi propionici*, var. *fuscum* Virtanen, 1923
dextrose, lactose, maltose, mannitol, sucrose	*B. tartricus* Grimbert, 1901

Products Substrates	Microorganisms Authors
Succinic ac. (cont.)	
dextrose, mannitol	*B. cloacae*, *B. coli* *B. lactis aerogenes* Thompson, 1912
dextrose, mannitol	*B. lactis aerogenes* Harden and Walpole, 1906
dextrose, mannitol	*B. coli communis* Grey, 1918
dulcitol	Pneumobacillus of Friedländer Grimbert, 1896
dulcitol, mannitol	*B. ethacetosuccinicus* Frankland and Frew, 1892
fumaric ac.	*B. pyocyaneus* Quastel, Stephenson and Whetham, 1925
glycerol	*Bact. aerogenes* *Bact. coli* *Bact. Freundii* Braak, 1928
glycerol	*B. lactis aerogenes* Harden and Norris, 1912
glycerol	*Rhizopus*, sp? Takahashi and Sakaguchi, 1927
glycerol	*B. subtilis* Vandevelde, 1884
glycerol	*B. coli communis* Grey, 1923
inositol	*B. lactis aerogenes* Kumagawa, 1922
i-inositol	*B. lactis* Hewitt and Steabben, 1921
α-ketoglutaric ac.	*B. xylinum* Iwatsuru, 1925
ketoglutaric ac.	yeast Neuberg and Ringer, 1914

Products Substrates	Microorganisms Authors
Succinic ac. (cont.)	
lactose	*B. lactis aerogenes* Emmerling, 1900
lactose	*B. coli* Grimbert, 1896
levulose	*Sarcina maxima* Smit, 1928
malic ac.	*B. coli communis* Grey, 1923
malic ac.	*B. lactis aerogenes* Emmerling, 1899
mannitol, glycerol	*B. ethaceticus* Frankland and Fox, 1889
starch	*B. subtilis* Fitz, 1878
starch	*Pectinobacter amylophilum* Makrinov, 1915
sucrose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930
sucrose	*Mucor mucedo* Fitz, 1873
sucrose	*Mucor racemosus* Emmerling, 1897
sucrose	yeast Kostytschew and Frey, 1925
tartaric ac.	*B. coli communis* Grey, 1923
tartaric ac.	*B. tartaricus* Grimbert and Ficquet, 1898
tartaric ac.	*Bact. termo* König, 1881
d-tartaric ac.	yeast Karczag, 1912
xylose	*Aerobacter faeni* Breden, Fulmer, Werkman and Hixon, 1930

Products Substrates	Microorganisms Authors
Succinic ac. (cont.)	
xylose	Pneumobacillus of Friedländer Grimbert, 1896
xylose	*B. paratyphoid*, *B. typhosus* Fred and Peterson, 1920
o-tolylacetyl carbinol	
o-tolylaldehyde	yeast Behrens and Iwanoff, 1926
p-tolylacetyl carbinol	
p-tolylaldehyde	yeast Behrens and Iwanoff, 1926
2, 2, 3-trichlorbutanol	
2, 2, 3-trichlorbutylaldehyde	yeast Rosenfeld, 1925
Trichlorethylalcohol	
trichloracetaldehyde	yeast Lintner and Lüers, 1913
Trimethylene glycol	
glycerol	*Bact. Freundii* Braak, 1928
n-valeraldehyde	
α-keto-n-caproic ac.	yeast Sen, 1923
Valeric ac.	
lactic ac.	*B. subtilis* Fitz, 1880
methyl-ethyl-acetaldehyde	*B. ascendens* *B. pasteurianum* *B. xylinum* Neuberg and Simon, 1926
methyl-ethyl pyruvic ac.	yeast Neuberg and Peterson, 1914
Xylonic ac.	
xylose	Sorbose bacterium Bertrand, 1913
Xylose (?)	
xylan	*Actinomyces sp.*? Patrick, Werkman and Hixon, 1930

CHAPTER IV

REFERENCES

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